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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 48456 and 48874.

48029 (AECL-3665) CHEMISTRY AND MATERIALS DIVISION. Progress Report, April 1–June 30, 1970. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 119p. (PR-CMa-13). Dep. CFSTI (U. S. Sales Only). AECL $2.50.

Progress is reported on ion penetration, electron microscopy, radiation damage, nuclear methods of analysis, nuclear chemistry, superconductivity, analytical chemistry, fuel analysis, radioactivity measurements, heavy water analysis, electrochemistry, spark-source mass spectrometry, mass spectrometry, radiation chemistry, isotope chemistry, surface chemistry, ceramic studies, and metal physics. Progress is reported from McMaster University on ternary fission studies and from the University of Western Ontario on x-ray diffraction analyses of oxide films and effects of oxygen in solid solution in zirconium on the oxide film growth. A topical review on irradiation and precipitation hardening of high-temperature zirconium alloys is also presented. (D.H.M.)

Chemical and Spectral Procedures

Refer also to abstracts 48153, 48249, 48340, and 48342.

48030 STUDY OF PYRIDINIUM TERNARY MOLYBDOPHOSPHATE COMPLEXES. COLLECTION OF TRACE AMOUNTS OF TITANIUM(IV), ZIRCONIUM(IV), AND THORIUM(IV). Murata, Katsuo; Ikeda, Shigero (Osaka Univ.). Anal. Chim. Acta; 51: 489-95(Sep 1970).

Trace amounts of titanium (IV), zirconium (IV), and thorium (IV) can be quantitatively collected from pyridinium solutions at pH 1 to 3 with the molybdophosphate complex. The metal ions react with molybdophosphate, and are then precipitated as the pyridinium ternary heteropoly salts. These salts were investigated by infrared spectrophotometry and thermogravimetric techniques. (auth)

48031 NEW METHOD FOR THE NEBULIZATION OF SOLID SAMPLES FOR ATOMIC ABSORPTION SPECTROSCOPY. Kashiki, Masayuki; Oshima, Shozo (Maruzen Oil Co., Ltd., Saitama, Japan). Anal. Chim. Acta; 51: 387-92(Sep 1970).

A dispersion system for the nebulization of solid samples for atomic absorption spectrophotometry is described. Compared to the conventional method of nebulization, the proposed method has the advantages of avoiding any preliminary dissolution step, and of requiring less sample. Absorbance measurements showed good sensitivity and stability. Powdered samples (<200 mesh) are dispersed in methanol with a special vibrating stirrer and the suspension is sucked directly into the flame. The method is applied to the determination of cobalt and molybdenum in alumina catalysts. (auth)

48032 CATHODE-RAY-EXCITED EMISSION SPECTROSCOPIC ANALYSIS OF TRACE RARE EARTHS. PART IV. DETERMINATION OF THULIUM IN ZINC SULFIDE. Larach, Simon; Shrader, Ross E.; Kauffunger, Richard A. (RCA Labs., Princeton, N. J.). Anal. Chim. Acta; 51: 393-8(Sep 1970).

The method for analysis of trace amounts of rare earths in a matrix by cathode-ray-excited emission spectroscopy has been extended to the determination of thulium in a zinc sulfide matrix, with lithium added as a charge-compensating ion. If the 478-nm emission from thulium is used as the detection wavelength, one ppB can be readily determined, with an estimated detection limit of the order of 0.01 ppB. Thulium determinations by this means were compared with those from solid-state mass spectrometry. Effects of sample firing parameters and interferences are discussed. (auth)

48033 DETERMINATION OF SMALL AMOUNTS OF AMINECARBOXYLIC ACID COMPLEXING AGENTS IN THE PRESENCE OF EXCESS TRIVALENT LANTHANIDES AND ACTINIDES. Wallace, R. M.; Hinton, J. F. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Anal. Chim. Acta; 51: 536-8(Sep 1970).

A relatively rapid and accurate method for the determination of aminecarboxylic acid complexing agents, such as EDTA, hydroxyethylethylenediaminetriacetic acid (HEDTA), or diethylenetriaminepentaacetic acid (DTPA) in solutions containing excess amounts of ions that form strong complexes, such as trivalent rare earth or actinide cations, is described. The method consists of adding an excess of Fe(III) to a sample of the solution containing the complexing agent. The solution is then passed through a cation exchange column containing resin in the sodium form; this resin retains the rare earths, actinides, and uncomplexed Fe, but not the complexed Fe, which is present as an anionic or neutral species. Since Fe forms a 1:1 chelate with aminecarboxylic acid complexing agents, the amount of chelate in the eluate from the column can be determined easily by determining the amount of Fe present. The results indicate that this method will be satisfactory for HEDTA, EDTA, and DTPA and also trans-1,2-diaminocyclohexane-N,N,N′,N′-tetraacetic acid (DCTA), ethylenebis-(oxyethylenenitrilo)tetraacetic acid, and perhaps other aminecarboxylic acids. (P.C.H.)

48034 PRESENT STATUS OF ELECTRON PROBE MICROANALYSIS. Malissa, Hanns (Technische Hochschule, Vienna). Pure Appl. Chem.; 21: 479-98(1970).

Few other analytical methods have expanded so rapidly as electron probe microanalysis during the past 10 years. The number of elements that can be determined or detected extends from beryllium to uranium and concentrations in the range 0.1 to 100 per cent can be dealt with. This has been made possible by the introduction of new analysing crystals and counting systems. The application of computer programming in conjunction with the various microprobe signals has allowed the development of valuable new methods for structural analysis. In commercial instruments the electron beam can be focused down to a diameter of 0.15 μm, hence the resolution of back-scattered or secondary electron images is excellent and a large amount of information can be gained on the topography and morphology of solid substances. When integrators with proper discrimination are used, new information on diffusion systems, etc., in solid materials can be obtained. With all these possibilities, the position of electron microprobe analysis is very strong. In addition to the use of x rays for quantitative work, many other signals arising from the interaction of electrons with the target can be utilized. (auth) (UK)

48035 CORRECTION FACTORS FOR ELECTRON PROBE MICROANALYSIS OF SILICATES, OXIDES, CARBONATES, PHOSPHATES, AND SULFATES. Albee, Arden L.; Ray, Lily (California Inst. of Tech., Pasadena). Anal. Chem.; 42: 1408-14 (Oct 1970).

Calibration curves for electron probe microanalysis of binary oxide systems can be closely described by the linear expression $C^A_{AB}/K^A_{AB} = \alpha^A_{AB} + (1 - \alpha^A_{AB})C^A_{AB}$, where C^A_{AB} is the concentration of oxide A in oxide binary AB relative to pure oxide A and K^A_{AB} is the background corrected intensity of a characteristic radiation line of the cation in oxide A in the oxide binary AB relative to that of pure oxide A. The binary correction parameter, α^A_{AB}, can be extended to multicomponent systems by using the concentration-weighted average of the binary parameters. Correction parameters have been calculated for 36 elements commonly occurring in natural silicates, oxides, carbonates, phosphates, and sulfates at 15 and 20 kV accelerating potential and 52.5° and 38.5° take-off angle. (auth)

48036 CHOLESTEROL DETERMINATION WITH FERRIC ACETATE–URANIUM ACETATE AND SULFURIC ACID–FERROUS SULFATE REAGENTS. Parekh, A. C.; Jung, D. H. (Indiana Univ. Medical Center, Indianapolis). Anal. Chem.; 42: 1423-7 (Oct 1970).

A new method for cholesterol determination using ferric acetate–uranium acetate in acetic acid and sulfuric acid–ferrous sulfate reagents is proposed. These reagents, while functioning as precipitants, serve to extract the cholesterol and also provide a color development with it, which is superior to the reactions reported in the literature. The new assay is not affected by lipemic, slightly hemolyzed, or icteric (up to 15 mg bilirubin/100 ml) sera. Repeated analyses of a pooled serum gave a result of 172 mg ± 1.82 standard deviation with ±0.30 as the standard error of the mean. Percent recoveries of cholesterol added to the sample were in the range of 98.5 to 100.7. The accuracy of the results obtained by the proposed assay is comparable to those obtained by using the reference method of Abell et al. The reproducibility of the proposed method is the best reported to date in the literature. (auth)

Radiometric Procedures

Refer also to abstracts 48200, 48239, 48260, 48286, and 48287.

48037 (BNL–50232) APPLICATION OF THE SLOWING DOWN SPECTROMETER TO NUCLEAR MATERIALS ASSAY. Beyster, J. R. (Brookhaven National Lab., Upton, N. Y.). Apr 1970. 28p. Dep. CFSTI.

The use of lead slowing down spectrometers, which uses a 14-MeV neutron source and lead shielding to moderate the spectrum to obtain the neutron energies of interest, for nuclear materials assay work is evaluated. Features of the spectrometer are discussed including calculations of intensities and estimates of isotope discrimination capabilities. Advantages and disadvantages of assay techniques based on the use of slowing down spectrometers are listed with suggestions for possible new research on the instrument. (D.H.M.)

48038 (LIB/Trans–299) ANALYSIS BY NUCLEAR REACTION FOR OXYGEN AND CARBON IN THIN LAYERS ON THE SURFACE OF METALS. Quaglia, L.; Robaye, G.; Cuypers, M.; Barrandon, J. N. Translated by B. Campbell (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Nucl. Instrum. Methods; 68: 315-24(1969). 24p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 23: 19667 (1969). (Australia)

48039 (RISO–210) QUANTITATIVE PAPER CHROMATOGRAPHY OF ^{14}C-LABELLED LONG-CHAIN FATTY ACIDS. Hansen, Heinz J. M. (Danish Atomic Energy Commission, Risoe, Research Establishment). Dec 1969. 59p. Dep. CFSTI (U. S. Sales Only).

Details are presented on the reversed-phase chromatography of fatty acids with undecane as the stationary phase and acetic acid as the mobile phase, combined with quantitative densitometry of the individual spots and automatic scanning of ^{14}C-activity with an anti-coincidence-corrected Geiger counter. The latter has a background of 0.3 cpm and a counting efficiency of 6%, including the absorption of the ^{14}C-β-particles by the paper. Examples of application are given from the field of lipid biochemistry, fatty acid mixtures being assayed down to a total specific activity of 0.2 μCi/g fatty acid. (auth)

48040 RADIOCHEMICAL ANALYSIS OF RADIUM, THORIUM, AND PROTACTINIUM IN URANIUM MILLING PROCESS SAMPLES. Terning, Jan-Ake (Chalmers Univ. of Tech., Goteborg). Int. J. Appl. Radiat. Isotop.; 21: 507-12(Sep 1970).

^{226}Ra, ^{230}Th and ^{231}Pa in solid and liquid process streams from a uranium mill were analysed. The concentrations of the elements in the range from 10^{-6} to 10^{-2} ppM were determined with an accuracy of about ±10 percent. (auth) (UK)

48041 SPECTROPHOTOMETRIC AND RADIOCHEMICAL DETERMINATION OF ZIRCONIUM BY SELECTIVE EXTRACTION WITH N-BENZOYL-N-PHENYLHYDROXYLAMINE. Villarreal, Robert; Young, John O.; Krsul, John R. (Argonne National Lab., Idaho Falls, Idaho). Anal. Chem.; 42: 1419-23(Oct 1970).

A highly selective method for the separation and determination of Zr was developed and applied to uranium-based fuels and various other materials. The procedure is based on the extraction of Zr with N-benzoly-N-phenylhydroxylamine (BPHA) into benzene from an ammonium carbonate solution containing several masking agents. Zirconium is back-extracted from benzene into an HBF_4–HCl solution, complexed with 8-quinolinol, and the colored complex extracted into xylene and measured at 390 nm. Of 60 metallic elements tested, only hafnium gave serious interference. Milligram quantities of citrate, tartrate, phosphate, sulfate, fluoride, cyanide, peroxide, and other common anions do not interfere; EDTA does interfere. Beer's law is obeyed from 0 to 70 μg of Zr in 10 ml of xylene; the optimum range is 8 to 55 μg of Zr. For the determination of Zr at the 0.05% level in uranium alloy, the relative standard deviation of the method is ±1.3%. The selectivity of the method makes it applicable to many types of samples. The selective and quantitative extraction of Zr with BPHA led to the development of a rapid procedure for the radiochemical determination of radioactive Zr isotopes. (auth)

48042 COMPUTER SYSTEM FOR USE IN QUANTIFYING LIQUID SCINTILLATION DATA. Haissig, Bruce E.; Schipper, Arthur L. Jr. (Dept. of Agriculture, St. Paul). Anal. Chem.; 42: 1456-8(Oct 1970).

A computer program was developed for conversion of semiquantitative data obtained from liquid scintillation spectrometry of disintegrations per minute (DPM) or microcuries per samples. Count data for single-labeled samples, double-labeled samples, or both can be quantified in a single run, even if methods of samples preparation or counting parameters are different. Gross counts per minute (CPM) are corrected for variable background, counting efficiency, and when necessary, spillover. The program is written in Fortran IV, with one version for the IBM 360 and another version for the CDC 6600. An example is given of percent error in estimating DPM of ^{3}H and ^{14}C in single- and double-labeled samples. (D.H.M.)

48043 RAPID RADIOCHEMICAL STRONTIUM SEPARATION. Bate, L. C. (Oak Ridge National Lab., Tenn.). Radiochem. Radioanal. Lett.; 4: 385-90(24 Sep 1970).

A rapid method for the separation of strontium from fission products using ^{85}Sr yield correction was developed. The sample with carrier is made basic in the presence of dichromate which removes many of the interfering radioactivities, including Ba, Y, and La, by precipitation as the chromate or hydroxide. The strontium is then precipitated with Na_2CO_3 from the radioactivities remaining in the solution. The sample can be counted after decay of the ^{137m}Ba daughter of ^{137}Cs, about 30 min. (auth)

48044 METHOD OF THE ISOLATION OF RADIORUTHENIUM FROM FISSION PRODUCTS OF URANIUM. Krtil, J.; Mencl, J.; Bulovic, V. (Nuclear Research Inst., Rez, Czech.). Radiochem. Radioanal. Lett.; 4: 355-63(24 Sep 1970).

The method described is based on the oxidation of ruthenium in two steps to RuO_4, which is extracted into CCl_4. Conditions for oxidation as well as for the extraction of various compounds of ruthenium were studied. The method was verified by the isolation of radioruthenium from irradiated uranium. (auth)

48045 CHEMILUMINESCENCE IN LIQUID SCINTILLATION COUNTING. Woods, A. H.; O'Bar, P. R. (Veterans Administration Hospital, Tucson, Ariz. Univ. of Arizona, Tucson). Anal. Biochem.; 36: 268-72(Aug 1970).

A chemiluminescence reaction arising from the combination of trichloroacetic acid and bathophenanthroline (indexed as 4,7-diphenyl-1,10-phenanthroline) during the liquid scintillation counting of the ^{59}Fe beta emission is described. It is compared to the previously reported chemiluminescence arising from a reaction between quarternary amines and peroxides. (auth)

48046 SEPARATION OF STRONTIUM ON CATIONIC RESIN FOR THE DETERMINATION OF RADIOACTIVE STRONTIUM. Bouquiaux, J. J.; Gillard-Baruh, J. H. C. (Institut d'Hygiene et d'Epidemiologie, Brussels). Radiochim. Acta; 14: 39-46 (1970). (In French).

A method for strontium separation, which requires only two successive passages through ion exchange columns, is described. This method is now in routine application for different types of samples such as rainwater, river and seawaters, air dust, food products (milk, wheat, complete meals), and bones. The sample solution (ashes in hydrochloric acid or acidified water sample) is passed through an acid Dowex column in order to remove the

anions and most of the cations. The remaining cations (alkaline earths) are eluted by means of 4N hydrochloric acid, and after evaporation are dissolved in a complexing EDTA solution. After the pH has been adjusted to 4.8 the solution is passed through an ammoniacal Dowex column on which strontium and barium, and part of the calcium are retained. The strontium is then selectively and quantitatively eluted by means of an EDTA solution adjusted to pH 6. The strontium-90 content is then calculated from the yttrium-90 activity. (auth)

Activation Procedures

Refer also to abstracts 48193, 48300, 48304, 48365, and 49848.

48047 (BNWL-1307(Pt.2), pp 11-13) GEOCHEMICAL OCEAN SECTION STUDY (GEOSECS). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

The trace elements Cs, U, Sb, Co, Sc, Fe, Zn, and Hg were determined in a single 25-ml sample of seawater by neutron activation and direct γ spectrometry using multidimensional and Ge(Li) analyzers. The methods for collection and treatment of samples are described. In general, the trace element concentrations of waters sampled during the pre-GEOSECS cruise were typical of those previously found in other oceanic waters. (P.C.H.)

48048 (BNWL-1307(Pt.2), pp 17-19) RADIOANALYTICAL PROCEDURE DEVELOPMENT. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

Methods are described for the multielement analysis of waters (river water, rainwater, and ice cores) by neutron activation, and also the determination of Pb in biological tissues by fast neutron activation. The multielement procedure eliminates ^{24}Na interference in neutron activation procedures and separates a radionuclide mixture into two separate groups for analysis. Lead is determined by its isotope ^{204}Pb, which has an appreciable inelastic scattering cross section for the production of ^{204m}Pb ($t_{\frac{1}{2}}$ = 67 min). (P.C.H.)

48049 (GA-9889) DEVELOPMENT OF NUCLEAR ANALYTICAL TECHNIQUES FOR OIL SLICK IDENTIFICATION (PHASE I). Bryan, D. E.; Guinn, V. P.; Hackleman, R. P.; Lukens, H. R. (Gulf General Atomic, Inc., San Diego, Calif.). 21 Jan 1970. Contract AT(04-3)-167. 134p. Dep. CFSTI.

Neutron activation analysis (NAA) has been found to quantitatively measure a large number of trace elements in crude oils and residual fuel oils. Examination of trace element concentrations in oils before and after exposure to wave action, elevated temperature, ultraviolet light, and bacteriological attack demonstrated that the large majority of these concentrations were only slightly affected by a minimal exposure, after which they were stable toward further exposure. Each trace element concentration represents an evidence point for comparison of oil samples, and it was found that there were more than enough stable evidence points determinable by NAA to distinguish between each of 40 different oil samples (20 crude oils and 20 residual fuel oils of the kind transported on U. S. waterways). Determination of $^{34}S/^{32}S$ ratios by Brookhaven National Laboratory of specimens of oil revealed that this ratio is another useful evidence point. (auth)

48050 (LYCEN-7038) SPURIOUS REACTIONS ENCOUNTERED IN THE DETERMINATION OF OXYGEN IN SILICON BY ALPHA PARTICLE ACTIVATION. Giroux, J.; Taivat, M.; Thomas, J. P.; Tousset, J. (Lyon Univ. (France). Institut de Physique Nucleaire). 13 May 1970. 13p. (In French). Dep. CFSTI (U. S. Sales Only).

Reactions inducing ^{18}F activity in silicon and their influence on the determination of small quantities of oxygen in silicon by the reaction $O \xrightarrow{\alpha} {}^{18}F$ were studied. When the irradiation was carried out with 54-MeV alpha particles, the profile of the ^{18}F production curve in the silicon indicated an activity that decreased very rapidly from the surface, until a depth of 500μ was reached, without demonstrating any effect due to the activation curve. The diffusion of the ^{18}F nuclides created in the oxide layer at the surface could not explain this result. The difference between these curves was attributed to spurious reactions inducing ^{18}F activity in silicon. In order to confirm the existence of the $Si \xrightarrow{\alpha} {}^{18}F$ reaction, the curve profiles of ^{24}Na and ^{29}Al produced by other spurious reactions in silicon were investigated. It was pointed out that the choice of incident energy was very critical. For the detection of oxygen in silicon, 54-MeV alpha particles were shown to be unsuitable. The best energy range should be around 35 MeV. (auth) (France)

48051 OCEANOGRAPHIC INVESTIGATIONS USING A SECTOR-FOCUSING CYCLOTRON. Eisele, J. A.; Larson, R. E.; Wilkniss, P. E. (Naval Research Lab., Washington, D. C.). Int. J. Appl. Radiat. Isotop.; 21: 219-24(Apr 1970).

The NRL sector-focusing cyclotron is a source of protons, deuterons, and helium nuclei with energies variable from a few MeV up to 75 MeV for protons. Proton activation of sea water salt enables one to measure calcium, strontium, bromine, and sulfur without chemical separation and without interfering radiation from sodium or chlorine. Charged particle reactions are also useful in producing particular radioactive isotopes. Flourine-18 has been produced by the $^{16}O(\alpha,d)^{18}F$ reaction on Li_2O. Following a simple chemical procedure, carrier-free and uncomplexed ^{18}F has been introduced into sea water for a variety of chemical oceanography experiments. (auth) (UK)

48052 DETERMINATION OF SCANDIUM AND GOLD IN METEORITES, TEKTITES, AND STANDARD ROCKS BY NEUTRON ACTIVATION ANALYSIS WITH AN INTERNAL-REFERENCE METHOD. Nomura, K.; Mikami, A.; Kato, T.; Oka, Y. (Tohoku Univ., Sendai). Anal. Chim. Acta; 51: 399-408(Sep 1970).

An internal-reference method has been established for the determination of scandium and of gold by neutron activation analysis, with calcium and platinum, respectively, as the reference elements; the method has been applied to the determination of both elements in several materials of geochemical origin. The composite γ spectra of scandium and gold activities arising from scandium and gold in a sample and from the element used as reference by the (n,γ) reaction followed by the β-decay are measured. The results can be calculated on the basis of the activity ratio of the two species in terms of the photopeak areas. The success of the method depends on chemical separations and on the high resolving power of a lithium-drifted germanium detector. Sensitivity and accuracy were assessed by analyzing synthetic mixtures of known composition. The proposed method was verified to be accurate for both elements even at ppB levels. The Bruderheim and Canyon Diablo meteorites, Indochinite tektite, and standard rocks, G-I, W-I, and JG-I were tested. (auth)

48053 DETERMINATION OF RHENIUM IN SEA WATER. Matthews, A. D.; Riley, J. P. (Univ. of Liverpool). Anal. Chim. Acta; 51: 455-62(Sep 1970).

A neutron activation procedure has been developed for the determination of rhenium in seawater. Anion exchange with Deacidite FF is used as a preconcentration stage. Rhenium is eluted with 4 M nitric acid and submitted to irradiation with thermal neutrons. Rhenium-186 is separated from other induced activities by solvent extraction and by an almost specific ion-exchange process employing mixed aqueous-organic solvent. Finally, rhenium is precipitated as tetraphenylarsonium perrhenate for determination of chemical yield and counting. Water from intermediate depths in the Atlantic was found to contain 6 to 8 ng Re l^{-1}. (auth)

48054 TECHNIQUES OF ACTIVATION ANALYSIS AND THEIR IMPORTANCE IN BIOLOGY. Kasperek, K. (Kernforschungsanlage, GmbH, Juelich, Ger.). Kerntechnik; 12: 207-12(May-Jun 1970). (In German and English).

The activation analysis techniques used at the Institute for Medicine, Juelich, Germany, for determining trace element concentrations in biological specimens are described. Examples of techniques used in actual investigations include: determination of normal levels of trace element concentrations in serum; determination of trace element concentrations in scalp hair; experimental studies of cardia insufficiency induced by $CoCl_2$; and absorption studies of elements enriched with stable isotopes. (auth)

48055 NEUTRON ACTIVATION ANALYSIS OF SOME MINERAL WATERS OF GEORGIA. Mosulishvili, L. M.; Kuchava, N. E.; Ginturi, E. N. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 59: 93-6(Jul 1970). (In Russian).

The neutron activation method was used to determine trace amounts of Ag, Co, Sc, Cs, Zn, and Sr in some mineral waters of Georgia. Results are reported on the contents of these elements in the mineral drinking waters, and other mineral waters. (auth)

48056 NEUTRON ACTIVATION ANALYSIS FOR CORRELATING VOLCANIC ASH SOILS. Borchardt, Glenn Arnold. Corvallis, Oreg.; Oregon State Univ. (1970). 232p. University Microfilms Order No. 70-7917.

Thesis.

Studies were made to determine the trace element differences between sample sites and between deposits of Mazama, Newberry, Glacier Peak, and St. Helens volcanic ash in the Pacific Northwest;

to correlate volcanic ash in peat bogs with volcanic ash from upland sites; to verify Mazama ash as parent material of soils occurring along a 450 km transect in Oregon; and to determine the trace element composition of clays derived from volcanic ash. Samples were irradiated in a TRIGA Reactor, followed by detection of elements with a high-resolution 30cc Ge(Li) semiconductor detector and a 4096 multichannel analyzer. Gamma spectra were analyzed with a computer program. Field variability of Mazama and Newberry ash deposits in Oregon was about 5%, whereas the variability of the crystal-rich Glacier Peak and St. Helens ash of Washington was greater. The activation analysis data support previous identification of Mazama ash. At least 18 cm of Mazama ash (dated at 6500 to 7420 radiocarbon years) occurred in peat bogs up to 450 km from the source at Crater Lake, Oregon. An older ash layer from Glacier Peak (>9650 years) occurs in northeastern Oregon. Soils in northeastern Oregon may contain about 5 cm of St. Helens Y, a 3000 year old ash, mixed into upper horizons. The trace element compositions of volcanic glass from C horizons of soils along a 450 km transect in Oregon correlate with ejecta from Mt. Mazama. Enrichment and leaching effects in weathered horizons interfere with correlations that use variation analysis. However, the discriminant function classified Al and AC as well as C horizon samples with the Mazama group. Enrichment of transition metals in upper horizons occurred in the following order: Cr > Co > Fe = Sc. Na/Fe and Na/Co ratios were measures of weathering intensity. The abundances of Hf, Th, and the rare earth elements remained relatively unchanged throughout 6600 years of weathering. Sc/Fe, Th/Hf, La/Sm, and Th/Sm ratios were not changed appreciably by weathering. These stable ratios were used with discriminant function analysis to aid in correlation of weathered soil horizons. Weathering in soils developed on volcanic ash resulted in enrichment of trace elements in sand-size volcanic glass. This led to a study of the <2μ weathering products. The clay fractions of soils developed from Mazama ash contained phases other than glass. Rare earth element abundances were about three times the amounts found for unweathered volcanic glass. Sodium in the <2μ fraction was only 10% of the amount in glass while the transition metals were as much as nine times higher in clay than in glass. Such increases were remarkably similar for clays from five soils along the 450 km transect of Mazama volcanic ash derived soils. The abundances of Cr and Co, as well as Fe and Sc in clay fractions increased with weathering intensity in the Day Creek soil. The Sc/Fe ratio was 4×10^{-4} for both clay and the Mazama volcanic glass from which it was derived. Chemical treatments revealed the solubilities of rare earth elements in Day Creek clay to be greater than those in the more intensely weathered Parkdale clay. High Sc/Fe ratios indicated a possible detrital origin for the crystalline clay minerals comprising 20% of the clay fractions in both soils. Clays from non-ashy soils of western Oregon also contained high concentrations of transition metals and rare earth elements. An attempt to correlate clays from different volcanic ash layers revealed chemical similarities between soil clays from Glacier Peak and Mazama ash and lapilli, but the chemical composition was different for soil clays formed on Newberry lapilli. (Diss. Abstr. Int., B)

48057 GAMMA-RAY SPECTROMETRY IN ACTIVATION ANALYSIS WITH Be–D NEUTRONS. Jinno, Kiyokatsu; Ishii, Daido (Nagoya Univ., Japan). Radioisotopes (Tokyo); 19: 406-9(Sep 1970).

Experimental results of the activation with polychromatic fast neutrons produced by $^{9}Be(d,n)^{10}B$ reactions in a 2-MeV Van de Graaff accelerator are presented. These neutrons, although they do not have much energy to produce the usual fast neutron reactions, do induce usable (n,n′) and (n,γ) reactions. Sensitivity values of various elements and analytical applications of the Be-D neutron activation are presented. (auth)

48058 NEUTRON ACTIVATION ANALYSIS OF HIGH-PURITY SELENIUM. Ballaux, Christian. Ghent; State Univ. of Ghent (1969). (In Dutch).

Thesis.

Neutron irradiation of Se gives rise to the long-lived ^{75}Se and a number of short-lived Se isotopes. Also the isotopes ^{82}Br and ^{83m}Kr are formed by β-decay of $^{83m+83}Se$. Furthermore, different As and Ge isotopes are produced by (n,p) and (n,α) reactions. All these matrix activities can be separated by distillation from H_2SO_4–HBr acid at 200 to 220°C. This separation technique is selective: only the halogens and the metallic elements Re, Sn, Sb, and Hg codistill quantitatively while Te, B, and Au only distill partially. The isotopes, which do not distill, can be divided in β- and γ-emitters. The γ-emitters can be determined simultaneously in the residue of the distillation by high-resolution γ-spectrometry with a Ge–Li detector (resolution: 3 to 4 keV). The isotopes ^{24}Na, ^{42}K, ^{46}Sc, ^{51}Cr, ^{59}Fe, ^{60}Co, ^{64}Cu, ^{65}Zn, ^{72}Ga, ^{110m}Ag, ^{115}Cd, ^{140}La, ^{187}W, and ^{198}Au were present as appeared from the energies and the half-lives of the different photopeaks. Pure β-emitters can be precipitated from the residue of the distillation and counted with an end-window Geiger-Müller tube. Sulfur and P were determined simultaneously through the counting rates of ^{32}P from the Cd-covered and uncovered samples. These counting rates were corrected for the contributions of the $^{35}Cl(n,\alpha)^{32}P$ reaction and the $^{31}P(n,\gamma)^{32}P$ and $^{32}S(n,p)^{32}P$ reactions. The radiochemical purity of the ammonium phosphomolybdate precipitates was checked by absorption of the β-particles, decay-curve analysis, and γ-spectrometry. Thallium was separated as tetrathioureothallium(I) perchlorate and thallium(I) chromate. The isotope ^{204}Tl was counted. The most important impurities, which distill in H_2SO_4–HBr at 200 to 220°C, are Te and the halogens. ^{131}I, the daughter isotope of $^{131m+131}Te$, can be used for the determination of Te. The same separation technique can therefore be applied for the halogens and Te. These elements were separated by distillation from concentrated HNO_3 and precipitation as silver halogenides. Bromine could be determined by γ spectrometry with a NaI(Tl) detector. If counting was started 3 days after the end of irradiation, only the isotope ^{82}Br appeared to be present. In the used irradiation conditions the second-order interference on ^{82}Se could be neglected. The same counting technique can be applied for the determination of chlorine through the counting rate of ^{38}Cl if the silver halogenide precipitate is counted about 40 min after the end of irradiation. Because of the presence of ^{83}Br, which principally emits γ rays with an energy of 530 keV, I could not be determined through the ^{128}I-activity in the 443-keV energy region. The halogens could be determined simultaneously by γ spectrometry with a Ge(Li) detector. The amount of Te is markably lower than that of the halogens and also the sensivity is lower. For further purification ^{131}I was extracted into carbon tetrachloride and sodium bisulfite solution. Because of the low counting rate and a small ^{75}Se contamination, the silver iodide precipitate was measured by a selective β,γ coincidence counting. The halogens could be determined after a short irradiation (2 hr or 30 min) at a small neutron flux (10^{11} n/cm² sec). For the determination of the other elements the Se samples were irradiated for several days at a flux of 6.10^{12} or 10^{13} n/cm² sec. Additional methods of analysis were performed to investigate and eliminate possible systematic errors in the procedures. The flux-depression of a Se sphere of 1 g was also determined. Possible fluxgradients in the irradiation capsule were investigated. (Diss. Abstr. Int., B)

48059 DETERMINATION OF CARBON AND NITROGEN BY DEUTERON-INDUCED PROMPT GAMMA RADIATIONS. Chen, N. S.; Fremlin, J. H. (Univ. of Birmingham, Eng.). Radiochem. Radioanal. Lett.; 4: 365-74(24 Sep 1970).

The sensitivities for the activation analysis of carbon and nitrogen in various metallic matrices using deuteron-induced prompt γ radiations were found to lie between 100 and 1000 ppM. A method for determining carbon/nitrogen ratios by comparing the peak areas in the prompt γ-spectra is described. (auth)

48060 ACTIVATION ANALYSIS OF CARBON IN HIGH-OXYGEN-CONTENT MATERIALS. Chen, N. S. (Univ. of Birmingham, Eng.). Radiochem. Radioanal. Lett.; 4: 375-80(24 Sep 1970).

A simple relative method for determining trace amounts of carbon in samples with high oxygen content is described. ^{13}N was produced from ^{13}C by deuteron bombardment, and ^{17}O was used as an internal standard by the reaction $^{17}O(d,n)^{18}F$. (auth)

48061 DETECTION OF ELEMENTS IN TEETH BY MEANS OF NEUTRON ACTIVATION. van Wyk, C. W. (Univ. of Witwatersrand, Johannesburg); Retief, D. H. Diastema; 2: No. 3, 33-4(1968-69).

Ten elements, Sr, Zn, Br, Mn, Cu, Cl, Ca, Fe, Co, and Sn, were determined in extracted teeth by neutron activation and γ spectrometry. For the determination of the long-lived isotopes, Fe, Zn, Co, and Sn, a chemical separation of Na by means of ion exchange resin is necessary. (B.L.M.)

48062 COMPARATIVE ANALYSIS OF VARIANCE OF THE KJELDAHL NITROGEN AND A NEUTRON ACTIVATION NITROGEN TECHNIQUE. Doty, W. H. (Ralston Purina Co., St. Louis); Munson, A. W.; Wood, D. E.; Schneider, E. L. J. Ass. Offic. Anal. Chem.; 53: 801-3(Jul 1970).

A comparative study of the variance components of a neutron activation nitrogen analysis and the Kjeldahl nitrogen analysis was conducted. A total of 448 individual assays were made by each method on 56 samples covering 17 types of feeds and ingredients. The coefficient of variation of the neutron activation data was 1.07. The coefficient of variation of the Kjeldahl data was 0.58. The statistical treatment showed no operator variance in the highly automated neutron activation technique. The total within-laboratory variance was divided evenly between day and error variance in the

neutron activation procedure. In the Kjeldahl technique, the greatest portion of the within-laboratory variance was seen in the error (differences/duplicate determination) component. (auth)

48063 NEUTRON ACTIVATION DETERMINATION OF THE AEROSOL CONTENT OF GREENLAND SNOW. Federer, Bruno (Swiss Inst. for Snow and Avalanche Research, Davos). Pure Appl. Geophys.; 79: 120-7(1970/II).

The concentrations of Na^+, Cl^-, and SO_4^{2-} were measured as a function of time in snow from Jari-Joset, Greenland. Large sulfate to chloride ratios and a strong parallelity between sulfate and sea components were obtained in the period 1880 to 1968. The possible origin of the excess sulfate and the reason for the parallelity are discussed. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 48131, 48144, 48148, and 49018.

48064 (ORNL-4581) CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 20, 1970. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 208p. Dep. CFSTI.

Seven sections are included; separate abstracts were prepared for six. The remaining section contains information on preparation, deamination, degradation, stereochemistry, and wet oxidation of organic compounds. (P.C.H.)

For abstracts of individual sections see: 48065–48067, 48111, 48148, and 49861.

48065 (ORNL-4581, pp 28-61) CHEMISTRY AND PHYSICS OF TRANSURANIUM ELEMENTS. (Oak Ridge National Lab., Tenn.).

From chemistry division annual progress report for period ending May 20, 1970.

Spectra of alpha-emitting yields from reactions of ^{231}Pu with protons at 44 and 63 MeV are presented. Nuclear energy states in ^{240}Pu were investigated by observation of γ rays emitted following beta decay of ^{240}Np isomers and following alpha decay of ^{244}Cm. A complete level scheme for ^{240}Np is presented. Attempts to produce the (0.34 ± 0.11)-yr isomeric state in ^{241}Pu from the ^{240}Pu (n,γ), the ^{242}Pu(n,2n), and the $^{238}U(\alpha,n)$ reactions were not successful. Thermal-neutron fission cross sections and resonance integrals of ^{245}Cm, ^{247}Cm, and ^{249}Cf were measured using the method of solid-state track recording. Alpha-particle spectra and excitation functions for production of ^{242}Cf, ^{241}Cf, and ^{248}Cf are presented. Measurements were made on the neutron absorption cross section of ^{257}Fm. Studies on the separation of recoil atoms of heavy elements were initiated. The search for superheavy elements in nature has not yet yielded positive results. In order to obtain information needed in the search for ekaosmium, the solution chemistry of osmium was studied. A theoretical interpretation of the tetrad effect, evident in the variation with atomic Z of liquid–liquid extraction data for the partition of lanthanides(III) and actinides(III) between various solvents, is presented. Crystallographic data are presented on the following complexes of certain actinide and lanthanide elements with cyclopentadiene: $Cm(C_5H_5)_3$, $Nd(C_5H_5)_3$, $Eu(C_5H_5)_3$, $Gd(C_5H_5)_3$, $Tm(C_5H_5)_3$, $Yb(C_5H_5)_2Cl$, and $Pr(C_5H_5)_3 \cdot CHIN$, where CHIN = cyclohexyl isonitrile. A fluorination method was developed for the synthesis of $Nd(C_5H_5)_3$ and $^{243}Am(C_5H_5)_3$. It was found that during the reaction of $BkCl_3$ with $Be(C_5H_5)_2$ the compound $Bk(C_5H_5)_2Cl_2$ is formed in addition to $Bk(C_5H_5)_3$. Optical spectra are given. The chelates, $Cs_2La(hfa)_5$ (where hfa is the anion from 1,1,1,5,5,5-hexafluoro-2,4-pentanedione), $Cs^{243}Am(hfa)_4$, and ^{243}Am-tris(2,2,6,6-tetramethyl-3,5-heptanedione) were prepared. In studies on the crystal structure of volatile chelates of lanthanide and actinide elements, it was found that $Am(thd)_3$ (where thd is 2,2,6,6-tetramethyl-3,5-heptanedione) is isostructural with $Nd(thd)_3$. Triindenylsamarium was synthesized and its crystal structure studied. Crystallographic data are presented for $AmCl_3$, $CmCl_3$, $BkCl_3$, and $CfCl_3$. A fast-closing valve was designed to protect Oak Ridge Isochronous Cyclotron from radioactive contamination. (J.G.B.)

48066 (ORNL-4581, pp 90-130) PHYSICAL CHEMISTRY. (Oak Ridge National Lab., Tenn.).

From chemistry division annual progress report for period ending May 20, 1970.

The ion-component treatment of free energy data was applied to mixtures containing NaCl, Na_2SO_4, $MgSO_4$, and $MgCl_2$ in aqueous solution. Equations for osmotic and activity coefficients were derived. Osmotic coefficient data for the systems, $HClO_4-UO_2(ClO_4)_2-H_2O$ and $NaClO_4-UO_2(ClO_4)_2-H_2O$, were analyzed. In studies on the thermodynamic properties of aqueous solutions of $HCl-MgCl_2-NaCl$, activity coefficients were calculated. Measurements of the heats of dilution of the halide (except fluoride) salts of Li and Na were completed. Measurements were made on the heats of dilution of aqueous solutions of the Na salts of butyric and valeric acids and the tetrabutylammonium salts of butyric, valeric, and heptanoic acids. Tracer diffusion coefficients were determined for $^{36}Cl^-$, $^{65}Zn^{2+}$, $^{24}Na^+$, $^{45}Ca^{2+}$, $^{86}Y^{3+}$, and $^{42}K^+$, in aqueous sodium p-ethylbenzenesulfonate. In a program for development of dynamically formed membranes for desalination, hyperfiltration properties of polyacrylic acid–hydrous metal oxide membranes were studied. Results of an attempt to assign Raman and ir spectral lines that were previously reported for polywater to other chemical species are given. Other experimental data published to prove the existence of polywater were examined and refuted. High-temperature heat content measurements were completed on $NaBF_4$, KBF_4, $RbBF_4$, and $CsBF_4$. Heats and entropies of melting and transition are tabulated. Measurements were made on the solubility of Y in YCl_3 at high temperatures. A reference electrode for use in fluoride melts was successfully tested. The heat capacity of potassium hexachlorotechnetate was measured at low temperature. Enthalpies of fusion and transition for lead chloride were determined. The enthalpy of formation of potassium hexabromorhenate is reported. The effects of chloride, iodide, and hydrogen ions and of the hydrogen evolution reaction on polarization curves for the dissolution of zone-refined Ti in H_2-saturated acidic sulfate media were studied. Chronopotentiometric and voltametric analyses for the chloride ion in flowing streams by use of a channel electrode are described. A new cell for the rapid chronopotentiometric analysis for the chloride ion was designed, constructed, and tested. (J.G.B.)

48067 (ORNL-4581, pp 131-82) CHEMICAL PHYSICS. (Oak Ridge National Lab., Tenn.).

From chemistry division annual progress report for period ending May 20, 1970.

Developments are reported for studies on: Raman spectra of solid and molten BeF_2 and Li_2BeF_4; Raman spectra of molten $NaBF_4$ to 556°C; dynamics of a polymer model for molten Li_2BeF_4; furnace for molten-salt Raman spectroscopy to 800°C; windowless cell for laser Raman spectroscopy of molten fluorides; paramagnetic resonance study of γ-irradiated single crystals of $KHCO_3$ and $KDCO_3$; and characterization of volatile and non-volatile solids obtained from the gas-phase radiolysis of pentaborane-9. (P.C.H.)

48068 SYNTHESIS OF ANHYDROUS UF_3. Friedman, H. A.; Weaver, C. F.; Grimes, W. R. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 32: 3131-3(Sep 1970).

A detailed account is given of the preparation of anhydrous UF_3 by the reaction $U + 3UF_4 \rightarrow 4UF_3$, in the presence of a reducing agent. The method of purifying the Mallinckrodt UF_4 from UO_2 impurity is described, and also the method of treating and drying the U turnings, which were converted to hydride by the action of H_2 at 275°C, the hydride then being decomposed at 500°C. The hydriding and decomposition steps were repeated, converting the U turnings into an ultrafine powder. The final reaction temperature was 900°C. An evacuated system was employed, since it afforded higher purity than inert gases and enhanced reaction between the solid phases. Alternative methods for the UF_4 purification are also described. Batches of several hundred grams of UF_3 were conveniently prepared with a yield of 98.5%. Neither U nor UF_4 was detected by x-ray diffraction analysis, and the product was not pyrophoric. (UK)

48069 STUDIES ON THE URANIUM TETRAFLUORIDE-HYDRAZINIUM(1+) FLUORIDE AND THE URANIUM TETRAFLUORIDE-HYDRAZINE SYSTEMS. Glavic, P.; Slivnik, J. (Inst. Jozef Stefan, Ljubljana, Yugoslavia). J. Inorg. Nucl. Chem.; 32: 2939-49 (Sep 1970).

The systems $UF_4-N_2H_5F-H_2O$, $UF_4-N_2H_4$ and $UF_4-N_2H_5F-N_2H_4$ were investigated. Complex fluorides $(N_2H_5)_2UF_6$ and $(N_2H_5)_3UF_7$ were isolated in the course of this investigation. The absorption spectra of solutions of UF_4 and N_2H_5F in water and in anhydrous hydrazine showed that the formation of UF_5^- and UF_6^{2-} species in such solutions depended upon the fluoride ion concentration. The solubility of uranium(IV) in these two systems was much higher than the solubility of uranium(IV) in the $UF_4-NH_4F-H_2O$ system. With UF_4 anhydrous hydrazine formed additional compounds of the formulas $UF_4 \cdot 1.5N_2H_4$, and $UF_4 \cdot N_2H_4$. Hydrolysis of UF_4, however, occurred if traces of water were present in the hydrazine. Infrared spectra of the compounds are given as well as the x-ray powder diffraction data. The thermal decomposition of the complex fluorides is discussed. (auth) (UK)

48070 PROGRESS IN REACTION KINETICS. VOLUME 5. Porter, G. (ed.). Elmsford, N. Y.; Pergamon Publishing Company (1970). 472p. $27.00.

Some of the principal growing points in reaction kinetics are reviewed. A separate abstract was prepared for one chapter.

The remaining chapters concern the determination of chemical reaction cross-sections; the kinetics of thermal decomposition of organic peroxides; excimer fluorescence of aromatic compounds; acid-base properties of excited states; the method of photoselection and some recent applications; the kinetics effects of pressure; and computers in reaction kinetics. (D.H.M.)

For an abstract of one chapter see: 48115.

48071 CORRELATION BETWEEN THE CATALYTIC ACTIVITY OF METAL OXIDES WITH RESPECT TO ISOTOPIC EXCHANGE IN MOLECULAR OXYGEN AND THEIR HEAT OF FORMATION. Klissurski, D. G.; Dikova, R. P. (Inst. of General and Inorganic Chemistry, Sofia). Z. Phys. Chem. (Leipzig); 241: 101-3(1969).

Limitations of the assumption of a direct proportionality between the activity of the metal oxides with respect to catalytic oxidation-reduction reactions and their corresponding heats of formation, expressed in kcal/g atom of oxygen are discussed. It is pointed out that the bonding energy in a metal oxide is not equal for all oxygen atoms. It is noted that the energy of activation and the rate of isotopic exchange in molecular oxygen vary in a definite way with an increase in the value of the enthalpy change associated with the transition from a lower to a higher oxide. Therefore, the activity of metal oxides, with respect to isotopic exchange in molecular oxygen, can be evaluated from the calculated value of the enthalpy change. (J.G.B.)

48072 CHEMICAL PROPERTIES OF SUPERHEAVY ELEMENTS. Fricke, Burkhard W. (Univ., Frankfurt am Main). pp 802-3 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Calculations of the chemical properties of superheavy elements are considered and the bases of these calculations discussed. Electron configurations are given for Z = 160 to 172. (M.C.G.)

48073 COMPOSITION AND STRUCTURE OF AMMONIUM URANATES. Cordfunke, E. H. P. (Reactor Centrum Nederland, Petten, Netherlands). J. Inorg. Nucl. Chem.; 32: 3129-31(Sep 1970).

In disagreement with previous results of the present author, Stuart and Whateley (Journ. Inorg. Nucl. Chem., 31: 1639 (1969)) stated that they did not find indications for distinct compounds in the system $UO_3-NH_3-H_2O$ but only a single phase system in which the NH_3/U ratio could be varied continuously. In order to elucidate the apparent discrepancy the author repeated his experiments, together with those of Stuart and Whateley. This involved not only equilibrating mixtures of UO_3 (amorphous), NH_3, and H_2O of known composition, but also mixtures of $UO_3 \cdot 2H_2O$, NH_3, and H_2O. Equilibrating times of 1 to 18 weeks were used. Infrared spectra were taken, and the results are discussed. The results obtained with UO_3 (amorphous) completely confirmed previous measurements, four distinct compounds being obtained: $UO_3 \cdot 2H_2O$; $UO_3 \cdot 0.33\ NH_3 \cdot 1.67\ H_2O$; $UO_3 \cdot 0.5\ NH_3 \cdot 1.5\ H_2O$; and $UO_3 \cdot 0.067\ NH_3 \cdot 1.33\ H_2O$. It was concluded that the asymmetric stretching frequency cannot be used as a measure for the NH_3/U ratio of these uranates (as was done by Stuart and Whateley). When $UO_3 \cdot 2H_2O$ was used as starting material, it appeared that equilibrium was only very slowly attained, and this appears to be the explanation for the discrepancy. Samples showed cation exchange properties, but it is evident that this cannot be used in support of the proposal that the system is continuous and homogeneous. (U.K.)

48074 HYPERFINE STRUCTURE OF THALLIUM IODIDE AND AN UPPER LIMIT FOR THE ELECTRIC HEXADECAPOLE MOMENT OF THE IODINE NUCLEUS. Stephenson, David A.; Dickinson, J. Thomas; Zorn, Jens C. (Univ. of Michigan, Ann Arbor). J. Chem. Phys.; 53: 1529-32(15 Aug 1970).

The hyperfine structure of thallium iodide has been studied in the J = 3 and J = 4 rotational states in an attempt to observe a nuclear electric hexadecapole effect. This study was carried out on a high-resolution molecular-beam electric resonance spectrometer at very weak electric and magnetic fields. The molecule is well described by the usual five hyperfine interaction constants which are (in kiloherts)

	$^{205}Tl^{127}I$	$^{203}Tl^{127}I$
eqQ	−438 916.3 ± 0.5	−438 917.3 ± 1.0
c_1	3.05 ± 0.05	3.09 ± 0.1
c_2	34.65 ± 0.15	34.36 ± 0.3
c_3	−2.48 ± 0.1	−2.59 ± 0.2
c_4	−6.67 ± 0.05	−6.57 ± 0.1

No evidence for a hexadecapole interaction constant as large as 500 Hz was found; this result is interpreted as setting an upper limit of $\sim 10^{-47}$ cm^4 for the nuclear electric hexadecapole moment of ^{127}I. (auth)

48075 MICROWAVE SPECTRUM OF METHYLBROMODIAZIRINE. Wollrab, James E. (McDonnell Douglas Research Labs., St Louis). J. Chem. Phys.; 53: 1543-6(15 Aug 1970).

Ground-state rotational spectra of $CH_3{}^{79}BrCN_2$ and $CH_3{}^{81}BrCN_2$ have been assigned, and a set of calculated r_0 structural parameters are: r(NN) = 1.240 ± 0.005 Å, r(CBr) = 1.904 ± 0.02 Å, ∠ CCBr = 116.5° ± 2.0°, and ∠ CCN_2 = 124.5 ± 2.0°. The Br quadrupole coupling constants (megahertz) for $CH_3{}^{79}BrCN_2$ are χ_{aa} = 539.8 ± 8.0, χ_{bb} = −279.4 ± 6.0, χ_{cc} = −260.4 ± 8.0 and for $CH_3{}^{81}BrCN_2$ are χ_{aa} = 451.1 ± 8.0, χ_{bb} = −232.3 ± 6.0, and χ_{cc} = −218.8 ± 8.0. A preliminary value for the barrier to internal rotation is 1.7 kcal mol^{-1}. (auth)

48076 HYPERFINE STRUCTURE OF THALLIUM BROMIDE. Dickinson, J. Thomas; Stephenson, David A.; Zorn, Jens C. (Univ. of Michigan, Ann Arbor). J. Chem. Phys.; 53: 1525-9 (15 Aug 1970).

The hyperfine structure of the J = 2 and J = 3 rotational states of TlBr was measured with a molecular-beam electric resonance spectrometer. Hyperfine transition frequencies were measured under conditions of very weak electric and magnetic fields. The linewidth was 500 Hz. The hyperfine interaction constants were determined for $^{205}Tl^{79}Br$, $^{203}Tl^{79}Br$, $^{205}Tl^{81}Br$, and $^{203}Tl^{81}Br$, in the first vibrational states for J = 2. In addition, the interaction constants for J = 3, v = 0 were determined for $Tl^{79}Br$ and $Tl^{81}Br$, but it was not possible to resolve the effect of the two thallium isotopes in the J = 3 state. The spectra measured are well described by a hyperfine Hamiltonian containing the bromine quadrupole interaction, the spin–rotation interactions of both the thallium and the bromine nuclei, and both the scalar and tensor parts of the spin–spin interaction between the nuclei. The dependence of the magnetic hfs constants on vibrational state and on isotopic composition shows good agreement with theory. The magnetic octupole interaction of the bromine nucleus in TlBr is negligibly small, and we find no evidence for nuclear polarization or pseudoquadrupole effects. (auth)

48077 PHONON CURVES AND FREQUENCY DISTRIBUTION FOR HYDROGEN-BONDED SYSTEMS: β MODIFICATION OF SOLID HCOOH, HCOOD, AND DCOOH. Tubino, Riccardo; Zerbi, Giuseppe (CNR, Milan). J. Chem. Phys.; 53: 1428-32(15 Aug 1970).

Molecular vibrations of the β form of solid formic acid and of its deuterated isotopes are studied throughout the first Brillouin zone with the use of a Urey–Bradley force field. Phonon dispersion curves and related densities of states are calculated. It is shown that low-energy phonons arising from the hydrogen bond are strongly dispersed. The time of flight neutron spectrum reported by others is discussed and interpreted. (auth)

48078 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. August 1970. Band 4, Heft 6. 233 Referate (Register-Nr. 2563-3020), 43 Referate (Register-Nr. 364T-406T). (Plutonium-Documentation, Abstract Journal with Appendix on Transplutonium Elements. August 1970. Vol. 4, No. 8. 233 Abstracts (Register No. 2563-3020, 43 Abstracts (Register No. 364T-406T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1970). 132p. (In German and English).

References (457) are given to review articles, progress reports, books, conferences, journals, and reports published mostly during 1969 and 1970 except for a few that were published earlier. The references pertain to information on: physical properties of Pu, its alloys, and its compounds; chemistry of Pu and its compounds, reprocessing, and isotope separation; alloys and metal–metalloid systems with Pu; Pu production by nuclear reactions; handling of Pu; utilization of Pu; economic problems, development programs; and history and bibliographies. (P.C.H.)

48079 LARGE REACTION KINETIC HYDROGEN–DEUTERIUM ISOTOPE EFFECT FROM THE VIEWPOINT OF ITS USE. Krumbiegel, Peter (Institut fuer Stabile Isotope, Leipzig). Z. Chem.; 8: 328-33(1968). (In German).

Attempts to utilize deuterium isotope effects for improvement of industrial products with respect to durability requires a search for high over-all isotope effect. Various reaction systems, such as autooxidation of Cumene at 65°C far exceed calculated values for K_H and K_D. Maximal possible ratios of hydrogen to deuterium are determined by 2 groups of parameters. One group is represented by the framework of the Bigeleisen theory. The other group comprises those parameters that lift the isotope effect beyond maximal levels and cause a tunnel effect, summation of reactions similar to a chain reaction, and induce alteration of the reaction sequence. At the present state of knowledge maxi-

mal isotope effects can be achieved when parameters of the two groups are in operation. Autooxidation is given as an example to show how the isotope effect can be enhanced by reaction conditions, structure of materials, and additives. (tr-auth)

48080 AMMONOLYSIS OF URANIUM HALIDES. PART 4. AMMONOLYSIS REACTIONS OF URANIUM IODIDES AND FLUORIDES. Burk, Werner (Zentralinstitut fuer Kernforschung, Dresden). Z. Chem.; 9: 233-4(1969). (In German).

The behavior of UI_4, UF_4, and UF_3 was studied under the effect of water-free ammonia and the products were analyzed with Debye x-ray diffraction. Above 350°C uranium nitride iodide was the major reaction product. Even at temperatures in excess of 1000°C UNI was still in existence. Thus, UNI proved more stable than UNCl or UNBr. Quite different was the behavior of UF_3 and UF_4 in ammonia. Below 300°C no reaction occurred. At higher temperatures and long reaction times, nitrogen content of reaction products increased; beyond 600°C, uranium nitride could be detected by x-ray diffraction. (H.B.G.)

48081 ENTHALPY OF FORMATION OF K_2UCl_4, $KUCl_3$, Na_2UCl_4, AND $KNaUCl_4$. Martynova, N. S.; Kudryashova, Z. P.; Vasil'kova, I. V. This paper was summarized in At. Energ. (USSR); 25: 226-7(Sep 1968) as paper No. 229. (In Russian).

The enthalpies of solution were measured and the enthalpies of formation of binary and ternary compounds that arise when components of the ternary system UCl_4–KCl–NaCl interact were calculated. The absence of stable complex ions in solution was verified from the results of titrating the most stable of the indicated compounds (congruently melting K_2UCl_4) with an HCl solution of iron chloride; potassium rhodanide was used as the indicator. Data are tabulated. (P.C.H.)

48082 ANNUAL REVIEW OF PHYSICAL CHEMISTRY. VOLUME 21. Eyring, H. (ed.). Palo Alto, Calif.; Annual Reviews Inc. (1970). 664p. $10.00.

Volume 21 of Annual Review of Physical Chemistry includes 21 chapters. About one-third of these chapters deal with subjects practically unknown 20 yr ago. Separate abstracts were prepared for the following 3 chapters: Excited States and Reactions in Liquids, Elementary Gas Reactions, and High Temperature Chemistry: Stabilities and Structures of High Temperature Species. (B.L.M.)

For abstracts of individual chapters see: 48083, 48084, and 48131.

48083 ELEMENTARY GAS REACTIONS. Spicer, Leonard D.; Rabinovitch, B. S. (Univ. of Utah, Salt Lake City. Univ. of Washington, Seattle). Annu. Rev. Phys. Chem.; 21: 349-86 (1970).

The effects of translational as well as internal energy in "driving" bimolecular reactions are discussed. Intramolecular vibrational relaxation in activated molecules and the roll of centrifugal effects in decomposition of such activated species are reviewed. Finally a brief discussion of the hydrogen–iodine reaction and the implications of recent work in this system are presented. (235 references) (B.L.M.)

48084 HIGH TEMPERATURE CHEMISTRY: STABILITIES AND STRUCTURES OF HIGH TEMPERATURE SPECIES. Hastie, J. W. (National Bureau of Standards, Washington, D. C.); Hauge, R. H.; Margrave, J. L. Annu. Rev. Phys. Chem.; 21: 475-98 (1970).

In this review attention is focused on the molecular properties and in particular the thermochemical stabilities and structure—geometrical, electronic, and vibrational—of high-temperature species. Such information provides the basic data necessary for a free-energy description of any hypothetical process involving high-temperature species over a wide range. Topics discussed are: experimental stabilities of high-temperature species, experimental determination of structure for high-temperature polyatomic species, theoretical approach to determination of molecular structure and stability, electronic configurations, and vibrational properties. An appendix is included in which geometries and frequencies from matrix infrared spectra are tabulated. (234 references) (B.L.M.)

48085 STUDIES ON THE PHOSPHATE COMPLEXES OF ACTINIUM AND LANTHANUM. Rao, V. K.; Shahani, C. J.; Rao, C. L. (Bhabha Atomic Research Centre, Trombay, India). Radiochim. Acta; 14: 31-4(1970).

Stability constants for the formation of $[Ac-H_2PO_4]^{2+}$ and $[La-H_2PO_4]^{2+}$ were determined at ionic strength 0.5M using the liquid cation exchanger, dinonyl naphthalene sulphonic acid (NH_4^+ form). It was found that in acid phosphate solutions (at pH 2.0 and 3.0), complexation occurs mainly with $[H_2PO_4]^-$ ion while complex formation due to $[HPO_4]^{2-}$ and $[PO_4]^{3-}$ ions is negligible. (auth)

48086 QUENCHING OF $Hg(6^3P_0)$ ATOMS BY HYDROGEN AND HYDROCARBONS. Vikis, Andreas C.; Moser, H. C. (Kansas State Univ., Manhattan). J. Chem. Phys.; 53: 1491-1501(15 Aug 1970).

Mercury atoms in the 6^3P_0 state were produced from the $Hg(6^3P_1)$ state by collisions of the second kind with N_2 under steady-state illumination with 2537 Å light in a static system. C_2H_4 was found to quench $Hg(6^3P_0)$ atoms, with a rate constant of 2.4×10^{13} cc $mol^{-1} \cdot sec^{-1}$, forming excited C_2H_4 which decomposes to C_2H_2 and H_2 with a mechanism similar to the $Hg(6^3P_1)$ photosensitized decomposition. The reduction in the yield of this reaction due to the addition of various gases was used to determine cross sections for the deactivation of $Hg(6^3P_0)$ atoms by H_2, D_2, CH_4, C_2H_6, C_3H_8, $CH_3CD_2CH_3$, c-C_3H_6, $C(CH_3)_4$, n-C_4H_{10}, and i-C_4H_{10}. The quenching cross sections relative to C_2H_4 are, respectively, 4.94×10^{-2}, 4.72×10^{-2}, $<1.0 \times 10^{-3}$, 4.0×10^{-4}, 3.9×10^{-3}, 3.1×10^{-4}, 1.8×10^{-4}, 4.3×10^{-4}, 6.8×10^{-3}, and 2.2×10^{-2}. Relative quenching cross sections for some of the preceding were obtained also from measurement of $Hg(6^1P_0)$ induced electron emission from Ag, and the results were in agreement with the first method. In general, $Hg(6^3P_0)$ reactions are similar in nature to other excited metal atom–molecule reactions. However, they exhibit much lower quenching cross sections and a more marked dependence on the strength of the C–H bond than do corresponding $Hg(6^3P_1)$ reactions. The inadequacy of simple models for quenching based solely upon conservation of total electronic angular momentum is discussed. The importance of both total excitation energy and C–H bond energy is shown by a comparison of the quenching cross section of $Hg(6^3P_0)$, $Hg(6^3P_1)$, and $Hg(6^1P_1)$ by the alkanes. The quenching cross sections for the saturated hydrocarbons exhibit large C–H vs C–D isotope effects. (auth)

48087 INFRARED SPECTRUM OF ^{6}Li HYDROXIDE. Decius, J. C.; Lilley, S. A. (Oregon State Univ., Corvallis). J. Chem. Phys.; 53: 2124-5(1 Sep 1970).

A comparison was made of the spectrum of ^{6}LiOH with a spectrum of LiOH containing the naturally occurring ratio of isotopes (92% ^{7}Li). Examination of the spectra of ^{6}LiOH revealed apparent shifts of the 3963 and 3377 cm^{-1} peaks such that they coincided with the peaks at 4000 and 3349 cm^{-1}, respectively. These shifts support the assignment of the peaks at 3960 and 3374 cm^{-1} as the summation and difference, respectively, of one of the fundamental hydroxide stretches and a lattice mode of 293 cm^{-1} involving lithium ions. (D.H.M.)

48088 ν_4 BAND OF $^{13}CH_4$. Kyle, Thomas G.; Blatherwick, Ronald D.; Bonomo, Francis S. (Univ. of Denver). J. Chem. Phys.; 53: 2800-4(1 Oct 1970).

Absorption spectra of methane enriched to 52% in the ^{13}C isotope were obtained in the 1300 cm^{-1} region with a 0.45 cm^{-1} resolution. The theoretical method of Hecht was used to determine the rotational and splitting parameters for the ν_4 band of $^{13}CH_4$. A line-by-line calculated spectrum, using the calculated line positions, is compared to the observed spectrum. (auth)

48089 CORRELATION OF ISOTOPE EFFECTS WITH MOLECULAR FORCES. I. THE DIATOMIC MOLECULE. Bigeleisen, Jacob; Ishida, Takanobu; Spindel, William (Univ. of Rochester, N. Y. Brooklyn College, N. Y. Yeshiva Univ., New York). Proc. Nat. Acad. Sci. U. S. A.; 67: 113-19(Sep 1970).

The convergence properties of the individual terms in the finite orthogonal polynomial expansion of the partition function of a harmonic oscillator were examined as a function of the energy of the oscillator and the temperature of the system ($u = \epsilon/kT$). The convergence of each term depends on the number of terms in the polynomial and the variable u. The jth term approaches within 1% of its asymptotic value when the order of the polynomial, n, equals $(u/\pi) + j + 1$. These favorable convergence properties of the finite polynomials were used to relate the partition function of an oscillator and the difference in chemical properties of isotopes directly to molecular and intermolecular forces. In the case of the diatomic molecule it is possible to treat the quantum corrections of any order in terms of a single particle function multiplied by kinetic energy-coupling factors. The latter are formulated as simple mass ratios of the order of unity. (auth)

48090 ELECTRONIC ABSORPTION AND FLUORESCENCE SPECTRA OF ANTHRACENE, $[D_{10}]$-ANTHRACENE, AND ACRIDINE IN n-ALKANE MATRICES AT 4°K. MacNab, Robert M.; Sauer, Kenneth (Univ. of California, Berkeley). J. Chem. Phys.; 53: 2805-17(1 Oct 1970).

A systematic examination was made of the electronic absorption and fluorescence spectra of anthracene and $[D_{10}]$-anthracene in n-hexane, n-heptane, and n-octane matrices at 4°K. Vibrational analyses were made and the correspondence between most of the modes of the two molecules was established. A number of errors

in previously published anthracene data are pointed out. The existence, in the fluorescence spectrum of anthracene in n-heptane at 4°K, of a line which lies 391 cm^{-1} above the electronic origin was found to be part of the environment multiplet structure characteristic of these matrix spectra. It is clear that the line has no connection with the intense 390 cm^{-1} vibrational frequency since its position with respect to the main origin is the same in the spectrum of [D_{10}]-anthracene, for which the vibrational frequency is 376 cm^{-1}. A possible hypothesis that fluorescence was occurring from vibrationally excited molecules is therefore ruled out. The distinction between "environment multiplets" for molecules in different crystal environments and spectral components deriving from local lattice vibrations is stressed. The environment multiplet structures of the undeuterated and deuterated molecules were found to be virtually identical. The 4°K spectrum of acridine in n-heptane shows some weak sharp lines on a broad background of absorption. The line shapes of the 77°K anthracene and 4°K acridine spectra are discussed in terms of the relative half-widths and intensities of components representing no-phonon and phonon transitions, respectively. (auth)

48091 PHOTOCHEMICAL ACCELERATION OF THE URANIUM(IV)–URANIUM(VI) ELECTRON EXCHANGE REACTION. Hoeschele, James David. East Lansing, Mich.; Michigan State Univ. (1969). 169p. University Microfilms Order No. 70-9560.

Thesis.

The kinetics of the U(IV)–U(VI) electron exchange reaction were investigated in aqueous $HClO_4$ solutions under conditions of constant incident light intensity. A low-pressure mercury vapor lamp, Model LO 735A-7 (Hanovia), was used as the light source, which emitted principally 2537 Å radiation. The exchange was inhibited by U(VI) and H^+, but accelerated by U(IV) and by increasing the temperature. Non-linear order graphs were obtained for U(IV), U(VI), and H^+ having the approximate orders of 0.41, −1.3, and −0.65, respectively. Overall quantum yields for exchange ranged from 0.01 to 0.1, based on the absorption of light by U(VI), and were determined by means of potassium ferrioxalate actinometry. Plausible exchange mechanisms are discussed in terms of a U(V) intermediate as produced by one or more of the following steps: (1) $U(IV) + O_2 \rightarrow U(V) + HO_2$, (2) $U(IV) + U(VI) \rightleftharpoons 2U(V)$, and (3) $UO_2^{2+} \cdot H_2O \xrightarrow{h\nu} UO_2^+ + OH + H^+$. A mechanism based on step (3) as the principal exchange path is in reasonable qualitative agreement with the experimental results. (Diss. Abstr. Int., B)

48092 ELECTRODEPOSITION OF ^{239}Pu IN AMMONIUM NITRATE SOLUTION. Kondo, Michio (Japan Atomic Energy Research Inst., Tokai); Akaishi, Jun; Tseng, Chia-lian. Nucl. Sci. J. (Taiwan); 7: 29-35(Oct 1969). (In Chinese).

Various factors such as concentration of electrolyte, current density, electrolysis time, distance between two electrodes, and quantity of electrolytes that affect the electrodeposition of ^{239}Pu in NH_4NO_3 were carefully examined. The results showed that the optimum condition is as follows: the quantity of the electrolytes is 5 to 6 ml, the concentration of the electrolyte is 1.5M, the current density is 170 to 300 mA/cm^2, with an electrolysis time of 2 hours. Other related factors that affect the electrodeposition are also given. (auth)

48093 TWO-PHOTON EXCITATION OF LUMINESCENCE IN URANYL CRYSTALS BY A RUBY LASER. Lyalin, G. N.; Solov'ev, L. E. (Leningrad State Univ.). Dokl. Akad. Nauk SSSR; 186: 73-5(1 May 1969). (In Russian).

The luminescence of uranyl nitrate, uranyl acetate, cesium uranyl nitrate, and potassium uranyl sulfate crystals and their frozen solutions in EPA (ether–isopentane–ethanol) with volume ratio of 5:5:2) excited by a ruby laser was studied. The excitation was done by transillumination and crystal radiation by means of crossed filters, and the ISP-51 spectrograph recorded photographically and photoelectrically. The luminescence was studied with 2- to 3-mm-thick monocrystals and excitation density up to 80 Mv/cm^2. (R.V.J.)

48094 RADIOCHEMICAL STUDY OF SELFDIFFUSION AND ISOTOPE EXCHANGE IN AQUEOUS SOLUTIONS. PART II. A NEW METHOD FOR DETERMINING ISOTOPE EXCHANGE WITHOUT ANALYTICAL SEPARATION OF COMPONENTS. Gosman, Alexandr (Technical Univ., Prague). Z. Phys. Chem. (Leipzig); 239: 222-8(1968).

The general theory of the method of determining simple homogeneous isotope exchange rates in solutions without analytical separation of components in an equimolar system is considered. The possibility of using this theory with a special apparatus for continuous investigation of self-diffusion in solutions is discussed. (auth)

48095 KINETICS AND KINETIC ISOTOPE EFFECT IN THE REACTIONS H/D + CH_4 AS STUDIED BY GAS PHASE ESR SPECTROMETRY. Kurylo III, Michael John. Washington, D. C.; Catholic Univ. of America (1969). 70p. University Microfilms Order No. 70-7334.

Thesis.

Direct measurements of the rates of the reactions of H and D atoms with CH_4 in the gas phase were obtained by following the H (or D) atom concentration by means of the atom's ESR absorption signal. The reactions were carried out in a conventional fast flow system. The H (or D) atoms were produced by passing a flow of H_2 (or D_2), highly diluted with inert gas, through a microwave discharge cavity. The H atom reaction was investigated over the temperature range from 424 to 752°K. The D atom reaction was studied from 361 to 732°K. Reproducibility of data at the higher temperatures was excellent in both systems. The rate constants for the reactions $H + CH_4 \xrightarrow{k_1} H_2 + CH_3$ and $D + CH_4 \xrightarrow{k_2} HD + CH_3$, were found to be $k_1 = 6.25 \pm 2.00 \times 10^{13} \exp\{(-11{,}600 \pm 300)/RT\}$ and $k_2 = 7.88 \pm 1.00 \times 10^{13} \exp\{(-11{,}000 \pm 150)/RT\}$, as determined from an Arrhenius plot of the rate data. The value of k_2 was calculated by assuming a stoichiometry of 2 for the D atom removal taking into account the reaction $D + CH_3 \rightarrow CH_3D + H$, which appears to be taking place under the reaction conditions. The observed kinetic isotope effect is compared with that predicted by transition state theory. The London-Eyring-Polanyi-Sato and the bond-energy-bond-order methods were employed to determine the properties of the activated complex. From these calculated force constants and bond distances in the activated complex the theoretical isotope effect was predicted for both a 3-atom and 6-atom model of the complex. In general, the agreement between the theory and experiments was quite good. (Diss. Abstr. Int., B)

48096 MECHANISM OF THE REACTION $H_2 + D_2 \rightarrow 2HD$. A SIMPLE MOLECULAR ORBITAL DESCRIPTION. Gimarc, B. M. (Univ. of South Carolina, Columbia). J. Chem. Phys.; 53: 1623-7 (1 Sep 1970).

A bimolecular mechanism is proposed for the exchange reaction $H_2 + D_2 \rightarrow 2HD$ based on simple molecular orbital calculations, qualitative molecular orbital pictures, and symmetry arguments. The mechanism assumes a broadside collision of one molecule with another, followed by rearrangement. (auth)

48097 INFRARED SPECTRA OF THE d_n-BOROHYDRIDE IONS. Coker, E. Howard; Hofer, Douglas E. (Univ. of South Dakota, Vermillion). J. Chem. Phys.; 53: 1652-6(1 Sep 1970).

Solid solutions of the d_n-borohydride ions in potassium bromide were prepared by diffusing the borohydride ions into optical grade single crystals. Their infrared spectra at 90°K yielded frequencies for each of the 24 infrared-active fundamental vibrations. Four fundamentals are significantly perturbed by Fermi resonance. The frequencies of the remaining 20 are reproduced to 10 cm^{-1} or better by the symmetry force constants $F_1 = 2.99$, $F_2 = 0.316$, $F_3 = 2.79$, $F_4 = 0.317$, and $F_5 = 0.018$ mdyn/Å. (auth)

48098 DIPOLE MOMENT AND HYPERFINE PARAMETERS OF $H^{35}Cl$ AND $D^{35}Cl$. Kaiser, E. W. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 53: 1686-1703(1 Sep 1970).

The molecular-beam electric resonance spectra of H ^{35}Cl and D ^{35}Cl were analyzed. The molecular constants obtained in the observed states are given. The dipole moments were used in conjunction with available absolute infrared intensity measurements of vibrational bands to obtain the dipole moment function of the molecule. The derivatives with respect to the internuclear distance R, evaluated at R_e, for H ^{35}Cl are: $(d\mu/dR)_e = +0.925 \pm 0.020$ D/Å; $(d^2\mu/dR^2)_e = +0.16 \pm 0.11$ D/Å^2; $(d^3\mu/dR^3)_e = -3.83 \pm 0.90$ D/Å^3; $(d^4\mu/dR^4)_e = -9.3 \pm 4.5$ D/Å^4. In addition, an isotope effect in the dipole moment due to a violation of the Born-Oppenheimer approximation was observed by comparing the relative HCl and DCl dipole moments. The distance derivatives of the field gradient, q_{Cl}, at the ^{35}Cl nucleus were also determined: $(dq_{Cl}/dR)_e = (+13.52 \pm 0.55) \times 10^{15}$ (esu/cm^3)/Å; $(d^2q_{Cl}/dR^2)_e = (-23.9 \pm 3.3) \times 10^{15}$ (esu/cm^3)/Å^2. The rotational magnetic moment of H ^{35}Cl (v = 0, J = 1) was measured, yielding the molecular g value: $g_J = +0.47 \pm 0.03$. This parameter, when combined with other available data, allowed a better determination of relative values of R_e in H ^{35}Cl and D ^{35}Cl: $R_e(H\,^{35}Cl) = 1.274700 \pm 0.000010$ Å; $R_e(D\,^{35}Cl) = 1.274652 \pm 0.000005$ Å. The isotope effect on R_e is apparent in this determination. (auth)

48099 ELECTRIC CONDUCTIVITY OF THORIUM OXIDE BETWEEN 500 AND 1400°C. Ullmann, Helmut (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Chem.; 9: 39-40(1969). (In German).

The electric conductivity of sintered thorium oxide samples with various contents of calcium oxide was measured in air between platinum electrodes through alternating current of 1,000 cycles/sec. For temperature measurement, thermocouples were attached directly to the samples. Below 1100°C, conductivity depended strongly on calcium oxide content. Above 1100°C, pure thorium oxide and mixtures with calcium oxide showed similar

conductivities with an activation energy of 2.0 eV. Theoretical calculations revealed that the observed data can be explained by diffusion of oxide ions. (H.B.G.)

48100 NEPTUNIUM(V) PEROXIDE. Musikas, C. (Comisariat a l'Energie Atomique, Fontenay-aux-Roses, France). Radiochem. Radioanal. Lett.; 4: 347-54(24 Sep 1970). (In French).

Spectrophotometric evidence is given for the Np(V) association with HO_2^- ions in alkaline medium. The oxidation state of complexed neptunium was verified by coulometric titration. A solid compound, probably Np(V) peroxide, was isolated at pH ~ 3.5 from aqueous solutions. (auth)

48101 COMPLEX COMPOUNDS OF URANIUM HEXAFLUORIDE WITH ALKALI-METAL FLUORIDES. COMMUNICATION I. Nikalaev, N. S.; Sadikova, A. T. This paper was summarized in At. Energ. (USSR); 25: 422-3(Nov 1968) as paper No. 241. (In Russian).

A new method for synthesizing fluorouranates in a solution of liquid hexafluoride is proposed to measure the self-ionization of hexafluorides according to the possible schemes; $2MeF_6 \rightleftharpoons MeF_7^+ + MeF_7^-$ and $2MeF_6 \rightleftharpoons MeF_5^{3+} + MeF_7^-$. The systems UF_6–MF, where M = Li, Na, K, Rb, or Cs, were investigated. At temperatures above 200°C, the following equilibrium phases were isolated: $Na_3U_2F_{15}$, KUF_7, $RbUF_7$, and $CsUF_7$. Thermogravimetric analysis, conducted in an atmosphere of argon, permitted a confirmation of the individuality of the compounds isolated and an establishment of the corresponding stages of their conversion with increasing temperature. In the case of the phases $Na_3U_2F_{15}$ and KUF_7, their decomposition occurred with a liberation of UF_6 molecules; in the remaining cases there was a destruction of the salt with liberation of fluorine. The stability of the phases isolated from a uranium hexafluoride melt increased from sodium salt to cesium salt, which was stable up to 540°C. (P.C.H.)

48102 TEST OF TRANSITION-STATE THEORY USING THE EXPERIMENTALLY DETERMINED RATE CONSTANT RATIO FOR THE REACTIONS $H + H_2$ AND $H + D_2$. Quickert, K. A.; Le Roy, D. J. (Univ. of Toronto). J. Chem. Phys.; 53: 1325-32(15 Aug 1970).

The rate constant ratio k_1/k_4 for the hydrogen-exchange reactions $H + H_2 \rightarrow H_2 + H$ [1] and $H + D_2 \rightarrow HD + D$ [4] was measured in the temperature range 290 to 690°K. Reactions [1] and [4] were carried out simultaneously, and k_1/k_4 was determined directly using only concentration ratios of stable molecules. The precision of the results was ±10% or better and it is believed that this also represents the accuracy. The experimental results were compared with the theoretical values of k_1/k_4 given by transition-state theory with quantum-mechanical tunneling, using the most recent ab initio potential surface of Shavitt, Stevens, Minn, and Karplus. The one-dimensional tunneling correction was calculated numerically using the minimum energy path on the surface. Good agreement between experiment and theory was found only when tunneling was included; scaling of the one-dimensional barrier, as suggested by the correlation work of Shavitt, improved the agreement. It is concluded that transition-state theory, as applied, leads to results for the hydrogen-exchange reactions which are not inconsistent with experiment. (auth)

48103 INFRARED SPECTRA OF METHOXYAMINE AND METHOXYAMMONIUM ION. Nelson, H. M. (Air Force Rocket Propulsion Lab., Edwards, Calif.). J. Chem. Phys.; 53: 1433-9(15 Aug 1970).

The infrared spectra of CH_3ONH_2, CH_3OND_2, $CH_3ONH_3^+Cl^-$, and $CH_3OND_3^+Cl^-$ were obtained in the region 4000 to 400 cm^{-1} with the samples in the form of thin crystalline films at liquid-nitrogen temperature. With the exception of the CH_3 and NH_3^+ torsions, all the fundamentals for methoxyamine and methoxyammonium ion have been observed and assigned. Davies and Spiers' assignments for CH_3ONH_2 have been revised in part and the NH_2 twist and wag located. The assignments for $CH_3ONH_3^+$ ion are readily correlated with those for CH_3ONH_2 and for both species the assignments for the A′ vibrations are consistent with the product rule. (auth)

48104 GAS-PHASE ABSORPTION SPECTRA AND DECAY OF TRIPLET BENZENE, BENZENE-d_6, AND TOLUENE. Burton, C. S.; Hunziker, H. E. (IBM Watson Research Center, Yorktown Heights, N. Y.). Chem. Phys. Lett.; 6: 352-8(15 Aug 1970).

Transients formed when benzene and toluene are excited by energy transfer from $Hg(^3P_0)$ atoms were investigated by a modulation-type kinetic spectroscopy method. Broad transient absorption bands were observed with maxima at 231.5 nm for benzene and 240.0 nm for toluene. Their oscillator strength was estimated to be 0.06. These absorptions were attributed to the hydrocarbon triplet state and assigned to the $^3E_{1g} \rightarrow {}^3B_{1g}$ electronic transition in benzene. Kinetic measurements indicated that the decay of the triplet state is not determined by a unimolecular process. Lifetime shortening at higher triplet formation rates occurred in a way consistent with an extremely rapid triplet-triplet bimolecular process. Secondary transients were observed in each hydrocarbon, and identified as triplet biphenyl in the case of benzene. (auth)

48105 RATE CONSTANT FOR DEUTERIUM ATOM RECOMBINATION CALCULATED BY THE ORBITING RESONANCE THEORY. Roberts, R. E. (Indiana Univ., Bloomington); Bernstein, R. B. Chem. Phys. Lett.; 6: 282-4(15 Aug 1970).

The resonance theory of termolecular recombination kinetics was applied to the reaction $D + D + D_2 \rightarrow 2D_2$. The isotope effect, the rate of deuterium recombination compared to that of hydrogen, was computed over the range 50 to 300°K. From 100°C to room temperature the ratio for D/H is 0.7$_1$ (±0.02), in agreement with the experimental value of Amdur (1935) and a very recent determination by Kaufman, Ham, and Trainar. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 48029, 48064, 48067, 48078, 48083, 48143, 48435, 48561, 49795, 49858, 49886, and 49887.

48106 (BNWL-1307(Pt.2), pp 43-4) CHARACTERIZATION OF RADIATION-INDUCED FREE RADICAL REACTIONS IN AQUEOUS SYSTEMS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

Studies were made on the chemical structures and reactivities of free radicals formed in irradiated model systems in order to understand and alleviate the development of radiobiological damage. Electron spin resonance spectroscopy and optical absorption spectrophotometry have been used to identify the radicals and determine the kinetics of their reactions with other biochemical substrates in aqueous solutions. The damage-propagating abilities have been assessed by studying their reactivities toward diagnostic reagents, while methods for chemical protection have been tested in synthetic systems resembling living tissue in particular aspects. (auth)

48107 (COO-1713-20) REACTION STUDIES OF HOT SILICON AND GERMANIUM RADICALS. Progress Report, September 1, 1969–August 31, 1970. Gaspar, Peter Paul (Washington Univ., St. Louis, Mo. Dept. of Chemistry). 31 Aug 1970. Contract AT(11-1)-1713. 11p. Dep. CFSTI.

Progress is reported on reactions of recoiling silicon atoms with phosphine, silane, and disilane; reactions of recoiling silicon atoms with phosphine–alkane mixtures; moderator studies; kinetics of silyl radical reactions; generation of silicon and germanium atoms by chemical methods; and improved instrumentation for recoil experiments. (D.H.M.)

48108 (LIB/Trans-282) KINETIC BEHAVIOR OF THE HO_2 RADICALS AND THEIR ACID FORM WITH RESPECT TO THE FERROUS AND FERRIC IONS. Pucheault, Jacques; Ferradini, Christiane; Buu, Antoinette. Translated by P. J. F. Newton (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Int. J. Radiat. Phys. Chem.; 1: 209-18 (Apr 1969). 13p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 23: 28887 (1969). (Australia)

48109 (NP-18452) ELECTRON SPIN RESONANCE STUDIES OF PRIMARY PROCESSES IN RADIATION INDUCED REACTIONS. II. SINGLE CRYSTAL 1,3-BUTADIENE. Shiga, Tetsuo; Lund, Anders; Kinell, Per-Olof. (Forskningradens Laboratorium, Studsvik (Sweden)). 1970. 13p. (LF-32). Dep. CFSTI (U. S. Sales Only).

The radical $-CH_2-\dot{C}H-CH=CH-CH_2-$ was formed irreversibly at 133°K by isomerization of the radical $CH_2=CH-\dot{C}H-CH_2-$ that was formed by γ-irradiation at 77°K. Isomerization proceeds by intramolecular hydrogen atom transfer. The first mentioned radical demonstrated anisotropic hyperfine coupling when the sample was rotated along the ampoule axis. When the magnetic field vector was in the radical plane perpendicular to the $C-H_\alpha$ bonds a septet was obtained separated by 18.5 G with an additional doublet splitting of 5.0 G. The observations of hyperfine coupling anisotropy and trans-conformity for the first radical suggest that it was located in an oligomer produced cationically by trans-1,4-addition. The existence of radical pairs at 77°K was confirmed. (auth) (SW)

48110 (NP-18453) ELECTRON SPIN RESONANCE STUDIES OF PRIMARY PROCESSES IN RADIATION INDUCED REACTIONS. I. 1,3-BUTADIENE ADSORBED ON SILICA GEL. Shiga, Tetsuo; Lund, Anders; Kinell, Per-Olof. (Forskningradens Laboratorium, Studsvik (Sweden)). 1970. 23p. (LF-31). Dep. CFSTI (U. S. Sales Only).

Following γ-irradiation of 1,3-butadiene adsorbed on silica gel, three kinds of radicals are observed at 77°K. The first is the cat-

ion radical $|CH_2-CH=CH-CH_2|^+$, whose ESR spectrum consists of a quintet of lines separated by about 11 G. The cation radical initiates polymerization of butadiene in the adsorbed state at 77°K. Propagation proceeds cationically. The second radical was the allyl-type radical, $CH_2=CH-\dot{C}H-CH_2-R$, which was located at the end of the polymer chains. The radical shows a change of the line profile with temperature. The third radical was also of the allyl-type, $CH_2-\dot{C}H-CH=CH_2$, and was a hydrogen atom addition type of radical. This radical was observed either with decreasing butadiene concentration or with a lower preheating temperature of the silica gel. (auth) (SW)

48111 (ORNL-4581, pp 70-83) RADIATION CHEMISTRY. (Oak Ridge National Lab., Tenn.).

From chemistry division annual progress report for period ending May 20, 1970.

Absorption spectra of transients produced in the flash photolysis of aqueous nitric oxide solutions and the electron pulse radiolysis of sodium nitrate are reported. In studies on energy transfer and degradation, yields of $NO_3 + N_2O_3$ and of NO were measured in the electron pulse radiolysis of NO-Ar and NO-N_2 mixtures. Luminescence was used to study NO produced by the pulse radiolysis of N_2-O_2. The density and reflectivity of amorphous ice, formed when water vapor is condensed on a surface cooled to 140°K or below, were studied. Results of previous studies on the primary yield of SO_4^- radicals in the radiolysis of aqueous H_2SO_4 were confirmed by an investigation of the reduction of cerium(IV) induced by the hydrolysis of peroxydisulfuric acid in aqueous 4.0M H_2SO_4 solutions. A kinetic study of the effects of Ce(III) and formic acid concentrations on Ce(IV) reduction produced evidence for a primary yield of NO_3 radicals in the radiolysis of 4.0M HNO_3 solutions. Selective bond breakage produced by the γ radiolysis of a homologous series of linear aliphatic acids was confirmed. Spectroscopic and chemical techniques were used to identify and measure the concentrations of stable γ-radiolytic products formed at room temperature in crystalline $KClO_3$, $CsBrO_3$, $CaIO_3$, $KClO_4$, $KBrO_4$, and KIO_4. The effects of an oxygen atmosphere of normal isotopic abundance on the γ radiolysis of ^{18}O-enriched KNO_3 are being studied by ir and Raman spectroscopy. Preliminary experiments indicate that atmospheric $^{18}O_2$ can be incorporated into the reactant KNO_3 and into the radiolysis product KNO_2. (J.G.B.)

48112 (ORNL-tr-2389) PURIFICATION OF INDUSTRIAL WASTE WATERS WITH HIGH-ENERGY RADIATION. Makarochkina, L. M.; Mikhailova, A. K.; Gershenovich, A. I.; Danilin, D. I.; Dzhagatspanyan, P. V.; Filippov, M. T. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Khim. Prom. (Moscow); 45: 905-9(1969). 13p. Dep. CFSTI.

Results of studies on the radiolysis of synthetic and actual waste waters containing biologically stable synthetic surface-active substances (SAS) are reported. Dilute water solutions of Nekal (a mixture of mono-, di-, and tributylnapthalenesulfonate), sulfonol (the sodium salt of m-dodecylbenzenesulfonic acid), and STEK (a sulfonate of paraffin and aromatic hydrocarbons) were studied. After γ irradiation of the solutions, SAS content, surface tension, degree of foam formation, and pH were determined. Results indicated that under the action of γ radiation all the compounds studied were converted to products that did not have surface-active properties. (J.G.B.)

48113 PULSE RADIOLYSIS STUDIES OF ELECTRON TRANSFER REACTIONS IN AEROBIC SOLUTION. Willson, R. L. (Mount Vernon Hospital, Northwood, Eng.). J. Chem. Soc., D; No. 16, 1005(Aug 1970).

The reaction of oxygen with the free radical intermediates of the nicotinamide adenine dinucleotide and the p-benzoquinone-hydroquinone oxidation-reduction couples were studied by pulse radiolysis. (auth) (UK)

48114 POLYMERIZATION OF MONOLAYERS. V. TACTICITY OF THE INSERTION POLY(METHYL METHACRYLATE). Blumstein, Alexandre; Malhotra, Shadi L.; Watterson, Arthur C. (Lowell Technological Inst., Mass.). J. Polym. Sci., Part A-2; 8: 1599-1615(Sep 1970).

Insertion poly(methyl methacrylate) (PMMA) formed within a monolayer of monomer adsorbed on montmorillonite was studied by means of NMR spectroscopy and shown to be composed of short stereosequences with a predominant isotactic component. The stereospecificity of the insertion PMMA can be understood in terms of the organization of the monomer adsorbed on the surface of the mineral. The monolayer of monomer is assumed to be composed of monads and isotactic diads due to dipole-ion interactions between the molecules of methyl methacrylate and exchangeable cations. Results of experiments relating factors such as temperature, density of ion population of the surface, and the nature of ions are discussed. It is shown that the populations of isotactic and syndiotactic triads P_I and P_S determined experimentally in the insertion PMMA are in a reasonable agreement with values calculated from the model. It is shown, furthermore, that P_I increases with increase in the density of the ion population, in agreement with the equations derived from the model. The polymerization was initiated by γ rays or free-radical catalysts. (auth)

48115 ION-MOLECULE REACTIONS IN RADIOLYSIS AND PHOTOIONIZATION OF HYDROCARBONS. Ausloos, P. (National Bureau of Standards, Washington, D. C.). Progr. React. Kinet.; 5: 113-79(1970).

Subjects discussed include, radiation sources; dosimetry; approaches to the study of ion-molecule reactions (analysis of neutral end products, absorption spectroscopy and electron spin resonance, mass spectrometry); theory and kinetics of ion-molecule reactions (lifetimes of ions and energetics of ion-molecule reactions, classification of reactions, theoretical formulations); and survey of ion-molecule reactions (particle transfer reactions, condensation reactions, and charge transfer reactions). (D.H.M.)

48116 RECOIL AND ANNEALING STUDIES IN NEUTRON-IRRADIATED CRYSTALLINE MOLYBDENUM HEXACARBONYL. Groening, Hugo R.; Harbottle, Garman (Brookhaven National Lab., Upton, N. Y.). Radiochim. Acta; 14: 109-11 (Aug 1970).

Crystalline molybdenum hexacarbonyl was irradiated with thermal neutrons, and studies were made on the retention of ^{99}Mo and ^{101}Mo in individual isochronal annealing experiments and also on the recoil chemistry of ^{99m}Tc and ^{101}Tc. The results on molybdenum isotope retention showed an isotopic effect for no annealing and also at all annealing temperatures. The isochronal curves appeared to have the structure of the typical step-annealing form. A single point was obtained for ^{99}Mo, annealed at 10°C, R(^{99}Mo = 60.4 ± 2%, in good agreement with the ^{101}Mo retention at the same temperature. In the recoil experiments, the results suggested that ^{101}Tc yields in the organic phase were much lower than those of ^{99m}Tc, where conditions were comparable. (P.C.H.)

48117 CHEMICAL RESULTS OF NUCLEAR PROCESSES IN MIXED CRYSTALS. VI. CHEMICAL RESULTS OF THE $^{80m}Br-^{80g}Br$ NUCLEAR ISOMERIC TRANSITION IN $K_2ReBr_6-K_2SnCl_6$ MIXED CRYSTALS. Mueller, Horst; Cramer, D. (Univ., Freiburg i.b.). Radiochim. Acta; 14: 78-83(Aug 1970). (In German).

The retention of the isomeric transition $^{80m}Br \rightarrow {}^{80g}Br$ in pure K_2ReBr_6 amounts to 100%, which means that following the nuclear transformation all ^{80g}Br is still bound as ligand. Two possibilities for such a behavior are discussed: first, ^{80g}Br retains its place in the lattice, the Re-Br bond is preserved or has been formed again after the bond breaking in consequence of the Auger cascade. Second, the bond has been destroyed and the recoiling ^{80g}Br recombines directly or by annealing with another central atom. Experiments with $K_2Re^{80m}BrBr_5-K_2SnCl_6$ mixed crystals have shown that for K_2ReBr_6 concentrations between 11 and 85 mole % the retention is always 100%. The conclusion is that the ^{80g}Br atoms have not left their original places in the lattice; otherwise, they were to be expected in the K_2SnCl_6 matrix as interstitial atoms of unknown valence state, as free bromine ions, or as ligands in $SnBrCl_5^{3-}$, especially in the most dilute mixed crystals. In all these cases they should have been transformed in free ^{80}Br during dissolution. The failure of Re-Br bond breaking in K_2ReBr_6 and a reported 65% probability of Br-O bond breaking in $KBrO_3$ following the $^{80m}Br-^{80g}Br$ isomeric transition can be understood by comparison of the crystal structures of both compounds and the calculated recoil energy of ^{80}Br and O, respectively, following the charge distribution over the molecule. In $KBrO_3$ the O recoil energy is greater and the oxygen atoms recoil into a part of the lattice which is not densely packed by other atoms. In K_2ReBr_6 ^{80}Br recoil is rendered more difficult by dense packing of atoms. (auth)

48118 RECOIL ATOMS FROM (n,γ) REACTIONS. Tumosa, Charles S.; Ache, Hans J. (Virginia Polytechnic Inst., Blacksburg). Radiochim. Acta; 14: 83-7(Aug 1970).

The reactions of neutral and charged recoiling ^{56}Mn species were studied with various substrates. The experimental design was such that possible internal conversion processes involved in the deexcitation of the compound nucleus following $^{55}Mn(n,\gamma)^{56}Mn$ were completed before the recoil species were allowed to reach the substrate molecules. No differences were observed in the reactions of charged or neutral ^{56}Mn with mylar, KCl, or $KClO_4$. The oxidation state of ^{56}Mn was invariably found to be Mn^0 or Mn^{+2}. The fraction of positively charged recoil Mn arriving at the target comprised about 78% of the ^{56}Mn escaping a thin Mn-metal film after thermal neutronirradiation. The balance of 22% consists of neutral recoiling ^{56}Mn species. (auth)

48119 CHEMICAL EFFECTS OF NUCLEAR REACTIONS IN DOPED COMPOUNDS. II. POTASSIUM CHROMATE DOPED WITH LANTHANUM. Costea, T.; Negoescu, Irina; Podeanu, Georgeta (Institut de Physique Atomique, Bucarest). Radiochim. Acta; 14: 87-93(Aug 1970). (In French).

The thermal annealing of reactor-irradiated pure and La-doped K_2CrO_4 was studied. It was observed that the activation energy of the annealing decreased as a function of the dopant ion concentration. Studying the shape of the isotherms and taking into account the structure of the defects produced by the La-ion incorporation, an annealing mechanism was proposed. The mechanism, based on electronic level schemes, may explain the phenomenology of the annealing and the activation energy diminution in the presence of defects. (auth)

48120 HOT-ATOM CHEMISTRY OF IRON IN IRON OXALATES. Siekierska, K. E.; Fenger, J. (Danish Atomic Energy Commission Research Establishment, Risoe). Radiochim. Acta; 14: 93-9(Aug 1970).

Samples of $FeC_2O_4 \cdot 2H_2O$, $Fe_2(C_2O_4)_3 \cdot xH_2O$, and $K_3Fe(C_2O_4)_3 \cdot 3H_2O$ were irradiated with thermal neutrons, and the relative yields of $^{59}Fe(II)$ and $^{59}Fe(III)$ were determined by radiochemical analysis. It appears that the $^{58}Fe(n,\gamma)^{59}Fe$ reaction can cause both reduction and oxidation of the recoil iron, and that the effect can be annealed out. The results were compared with previously published data on relative yields of $^{57}Fe(II)$ and $^{57}Fe(III)$, formed by the $^{57}Co(EC)^{57}Fe$ process in the same systems and measured by Mössbauer spectroscopy. Although some similarity was found between the Fe(II)/Fe(III) distributions, the two nuclear reactions can hardly have the same chemical consequences—this again is taken as an indication of little disorder in the reaction zone. (auth)

48121 INDIUM GENERATOR. Mirza, M. Y. (Pakistan Inst. of Nuclear Science and Tech., Rawalpindi). Radiochim. Acta; 14: 63-5(Aug 1970).

A simple and rapid method is presented for the separation of carrier-free ^{115m}In from neutron-irradiated enriched ^{114}Cd. The method utilized the elution of indium with 0.1 n HCl from Dowex-1 anion exchange resin. More than 95% indium activities with a decontamination factor of 10^6 from cadmium can be recovered in 20 min. (auth)

48122 SEPARATION OF CARRIER-FREE ^{111}Ag FROM NEUTRON-IRRADIATED PALLADIUM. Mirza, M. Y. (Pakistan Inst. of Nuclear Science and Tech., Rawalpindi). Radiochim. Acta; 14: 61-3(Aug 1970).

A simple and rapid method is presented for the separation of carrier-free ^{111}Ag from neutron-irradiated palladium. The method utilized the elution of silver with 10 N HCl from Dowex-1 anion exchange resin. 98% silver activities with a decontamination factor of 10^7 from palladium can be recovered in 20 min. (auth)

48123 CHEMICAL BEHAVIOR OF ^{132}I FORMED BY THE β DISINTEGRATION OF ^{132}Te IN ORGANIC MEDIUM. Llabador, Y. (Center de Recherches Nucleaires, Strasbourg). Radiochim. Acta; 14: 100-7(Aug 1970). (In French).

Studies were made on the role of energy and charge transfer processes that occur during the reactions of ^{132}I formed by $\beta-\gamma$ decay of ^{132}Te in mixtures of $(C_6H_5)_2Te$ and $(C_4H_9)_2Te$, one of the two compounds being labeled with ^{132}Te. The influence of a third constituant on the yields of $C_6H_5{}^{132}I$ and C_4H_9I in the solution has been studied. The results showed that the radiolysis of the organotelluric molecules in the autoirradiation zone result principally from energy transfer processes involving high excited states. (auth)

48124 SYNTHESIS OF TRANSMENDELEVIUM ELEMENTS IN NUCLEAR REACTIONS INDUCED BY HEAVY IONS. Druin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 657-65 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Nuclear reactions induced by heavy ions to produce elements with atomic numbers higher than 101 are considered. When a heavy ion interacts with the target nucleus, the reaction products are knocked out of the target due to a large momentum transfer. Methods of collecting these recoil atoms and transporting them from the irradiation zone to a zone where their chemical and physical properties are analyzed are discussed. Various methods used to produce elements above 101 are reviewed. (M.C.G.)

48125 INVESTIGATIONS OF TRANSURANIUM ELEMENTS AT BERKELEY. Nurmia, Matti (Univ. of California, Berkeley). pp 666-72 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Production of ^{256}No and other nobelium isotopes, lawrencium, $^{257}104$, $^{256}104$, and $^{258}104$ is discussed. (M.C.G.)

48126 RADIATION-INDUCED SOLUTION POLYMERIZATION OF N-SUBSTITUTED ACRYLAMIDES AND METHACRYLAMIDES. Zurakowska-Orszagh, Janina (Univ., Warsaw). Rocz. Chem.; 44: 1273-81(1970).

Some general considerations on the kinetics of radioinduced solution polymerization have been carried out. In the place of conventional parameters new variables were introduced: reduced time and conversion. Some particular cases of simplified and more detailed kinetics have been discussed. These calculations are compared with experimental data obtained for the series of N-substituted acrylamides and methacrylamides. (auth)

48127 ECONOMY OF THE LOW-TEMPERATURE PROCESS FOR HEAVY-WATER RECOVERY. Gutowski, H. (Linde AG, Hoellriegelskreuth, Ger.). Kerntechnik; 12: 238-41(May-Jun 1970). (In German and English).

Economic possibilities for a combination of the low-temperature process for heavy water recovery with hydrogen-producing processes are described. As an example, the design of a unit producing 105 tons/year of D_2O is presented. Process data as well as capital and production costs are reported. (auth)

48128 TECHNICAL STATUS OF THE LOW-TEMPERATURE PROCESS FOR HEAVY-WATER RECOVERY. Gutowski, H. (Linde AG, Hoellriegelskreuth, Ger.). Kerntechnik; 12: 233-7(May-Jun 1970). (In German and English).

The development of the low-temperature process for heavy water recovery has, taking the plants in Hoechst and Naugal as a basis, led to a so-called second generation. The improvement of the components production of refrigeration, hydrogen distillation, and rinsing of the cold-boxes is described in some detail. (auth)

48129 RADIATION CHEMICAL TRANSFORMATION OF INORGANIC ACIDS IN CONCENTRATED AQUEOUS SOLUTIONS. Bugaenko, Lenar Timofeewitsch (Lomonosov State Univ., Moscow). Z. Chem.; 8: 206-14(1968). (In German).

To distinguish between primary and secondary radioinduced reactions, addition of ion scavengers is the most useful tool. It is shown that perchlorate compounds undergo radiolysis only by direct radiation effects. Addition of cerium ions decreases the amount of chloride ions, while addition of iron ions leads to an increase. Thus, although the radiation effect is a direct one, end products are determined by outside agents. Behavior of the perchlorate ion is studied under the influence of γ radiation, soft x rays, and helium beams of 33 MeV. Under the influence of radiation, the perchlorate ion undergoes the following reaction: $ClO_4^- \rightarrow ClO_2 + O_2$. In a similar manner, sulfuric acid is studied for concentrations ranging from highly dilute to 100%. Under oxygen-free conditions, hydrogen peroxide is not formed; however, it is formed increasingly with enhanced oxygen pressure. Finally, very high concentrations of hydrochloric acid are studied and conditions described under which chlorine and hydrogen gas are liberated. Problems of future research about radiation effects on chemicals are outlined. (H.B.G.)

48130 RADIOTHERMAL RESISTANCE OF SOME ARYL SILANES. PART I. STUDY OF THE COMPOSITION OF GASEOUS PRODUCTS OF HIGH-TEMPERATURE RADIOLYSIS OF SILANES. Burdasov, E. N.; Khramchenkov, V. A. This paper was summarized in At. Energ. (USSR); 25: 225(Sep 1968) as paper No. 227. (In Russian).

The results are presented for an investigation on the stability of the aryl silanes $Si(CH_3)_3C_6H_5$ and $Si(CH_3)_2(C_6H_5)_2$ under the influence of temperature and radiation in a nuclear reactor in order to determine the usability of these compounds as coolants. The irradiation was carried out at temperatures of 50 to 390°C and total doses of absorbed energy of 360 and 720 Mrad; the dose power was 30 to 40 Mrad/hr. The activation energies were measured. The main radiolytic products of silanes were H, methane, 1,3-butadiene, and 2-butene with a low content of ethane, ethylene, acetylene, propane, 2-methylpropane, benzene, 1-butene, and 2-methylpropene. The initial temperatures of radiothermal cracking of 215°C for $Si(CH_3)_2(C_6H_5)_2$ and 150°C for $Si(CH_3)_3C_6H_5$ are indicative of the fact that the use of silanes as coolants is not feasible. (P.C.H.)

48131 EXCITED STATES AND REACTIONS IN LIQUIDS. Thomas, J. K. (Argonne National Lab., Ill.). Annu. Rev. Phys. Chem.; 21: 17-38(1970).

This short review points out the advances and contributions made by new techniques, such as lasers and pulsed accelerators, to both the mode of production and the understanding of the nature of the excited states. The review deals mainly with excited states in the liquid phase with occasional reference to the gas and solid phases. (179 references) (B.L.M.)

48132 SEPARATION OF CARRIER-FREE ^{64}Cu AND/OR ^{67}Cu FROM REACTOR-IRRADIATED ZINC BY MEANS OF THE SPONTANEOUS DEPOSITION OF COPPER ON PLATINUM

BLACK. Toth, G.; Fuessy, E. (Inst. of Isotopes, Budapest). Radiochem. Radioanal. Lett.; 4: 391-5(24 Sep 1970).

Separation of carrier-free ^{64}Cu and/or ^{67}Cu was performed by making use of the selective spontaneous deposition of copper on platinum black previously reduced with CH_3O. Assay of the decay curve and γ spectra of separated radiocoppers showed that radioimpurities do not exceed 0.1%. (auth)

48133 ELECTRON SPIN RESONANCE OF GAMMA-IRRADIATED 1-METHYLTHYMINE, 9-METHYLADENINE, AND THE CO-CRYSTAL COMPLEX OF THESE COMPOUNDS. Schmidt, John Joseph. University Park, Pa.; Pennsylvania State Univ. (1969). 75p. University Microfilms Order No. 70-7246.

Thesis.

Free radicals in γ-irradiated single crystals and polycrystalline samples of 1-methylthymine (1 MT) and 9-methyladenine (9 MA) were studied by ESR spectroscopy. Radical formation, stability, and conformation depend on the immediate environment of the attacked molecule. The two compounds studied occur in several known crystal structures. Polycrystalline samples were irradiated and observed at 77°K. The radical(s) formed in 1 MT at 77°K have extended hyperfine splittings, while those formed in the 1:1 co-crystal complex of 1-methylthymine and 9-methyladenine (1 MT: 9 MA) do not, indicating that the radicals formed in 1 MT are not formed in 1 MT: 9 MA at 77°K. The spectrum from 9 MA at 77°K is narrow, as in 1 MT: 9 MA but more symmetric, suggesting that the 9 MA species may be present in 1 MT: 9 MA. Upon irradiating at (or warming to) room temperature radicals are formed by hydrogen addition to C6 of the 1-methylthymine ring (thymyl radical) in both 1 MT: 9 MA and 1 MT; and by hydrogen addition to C8 and/or C2 in 9 MA and in 9-methyladenine dihydrobromide (9 MAHBr). Microwave power saturation studies indicate that radicals are preferentially formed at room temperature on the pyrimidine moiety of 1 MT: 9 MA, and that only 20 to 40% as many 9 MA radicals are formed in the complex as in an equimolar mixture (1 MT + 9 MA) control. A radical formed by abstraction of a hydrogen atom from the methyl group of 9 MA (not occurring, however, in 9 MAHBR) was discovered by analyses of single crystals. The CH_2 group is coplanar with the purine ring. Principal values of hyperfine interactions with these protons are, in gauss: $A_z^{H1} = 10.5$, $A_yH1 = 30.0$, $A_x^{H1} = 18.5$; $A_x^{H2} = 8.5$, $A_y^{H2} = 32.5$, $A_z^{H2} = 19.5$; with N9, $A_x^N = 3.0$; $A_y^N = 3.5$, $A_z^N = 3.9$. These values are typical. Small couplings (reasonably consistent with a simple Hückel calculation) for the C8 proton (in nondeuterated crystals) and N7 are also observed in some magnetic field orientations. The values of the axially symmetric g tensor are $g = 2.0021$ and $g = 2.0029$. An interesting conformational effect is observed at sufficiently elevated temperatures. At 106°C in deuterated crystals, or at 140°C in protonated crystals the proton couplings from H1 and H2 decrease by a few gauss and become equivalent with H along the crystal axes. Small changes in the x-ray diffraction powder pattern occur over the same temperature range, suggesting that a second-order phase transition is occurring. The temperature dependence associated with deuteration suggests that amino groups from molecules in adjacent layers are interacting with the $-CH_2$ group. Two effects noted for the thymyl radical in 1 MT and 1 MT: 9 MA may be associated with the extent of hydrogen bonding, which forms intermolecular chains in the latter but not the former. The first is a temperature-dependent warping of the pyrimidine ring, measured by inequivalence of C6 proton couplings which is pronounced in 1 MT but immeasurably small in 1 MT: 9 MA. The maximum warping is 3.4 to 5.3 degrees at −140°C and 2.7 to 4.0 degrees at 20°C in 1 MT. The second effect is the heat lability in 1 MT (conversion to an unknown radical species after four hours at 160°C) relative to 1 MT: 9 MA (stable). Both effects indicate superior stability in the co-crystal purine–pyrimidine lattice. (Diss. Abstr. Int., B)

48134 STUDY OF THE INFLUENCE OF GRAFTING ON THE CELLULOSE–WATER RELATIONSHIP. Lepoutre, Pierre-Francois. Raleigh, N. C.; North Carolina State Univ. (1969). 111p. University Microfilms Order No. 70-9167.

Thesis.

An unbleached Kraft softwood pulp containing 84% α-cellulose was grafted with polystyrene up to a 70% graft level using γ radiation and dioxane, containing 2.3% water, as swelling agent. Grafting results were: a) a reduction in the water sorption isotherm based on wood pulp content, particularly at low relative humidity, e.g., 40% reduction at 68% graft and 0.05 water activity; b) an increase in the water diffusion coefficient at zero moisture, e.g., a tenfold increase at 68% graft; c) a decrease in the water concentration dependence of the diffusion coefficient; d) a decrease in the heat of water sorption and a less negative entropy of sorption; e) an increase in density over the value calculated assuming ideal mixing of the two polymers; f) an increase in the sorption-desorption hysteresis. The further decrease in water sorption caused by drying at 110°C instead of 25°C was larger on grafted than on ungrafted cellulose but it also disappeared upon rewetting. The above changes were less significant when methanol was used as swelling agent and quite small when water was used, while grafting rates were considerably enhanced. Part of the polystyrene is believed to be located in the free volume initially present in the cellulose and sterically hinders the hydroxyl accessibility. Swelling of cellulose is retarded by the grafted polymer and the nonextractable homopolymer, which is below its glass-transition. Because of the heterogeneity of the grafted fiber consisting of cellulose, true graft-copolymer and homopolystyrene, water diffuses preferentially through the least resistance path offered by the homopolymer domain. At 10% grafting level, more polar polymers such as polyethylacryiate, polyacrylonitrile, and polyacrylic acid also caused a reduction in water sorption at low relative humidity but the reduction tends to disappear at high relative humidity. The water diffusion coefficient decreased as the polarity of the grafted polymer increased. (Diss. Abstr. Int., B)

48135 STRUCTURE AND REACTIONS OF TRAPPED ELECTRONS IN ACETONITRILE SYSTEMS. Bonin, Michael Arthur. Knoxville, Tenn.; Univ. of Tennessee (1969). 305p. University Microfilms Order No. 70-7548.

Thesis.

The discovery and the subsequent characterization of the physical and chemical properties of the trapped electron in crystalline acetonitrile-d_3 are described. The structure and reactions of trapped electrons in various crystalline acetonitrile systems were studied in detail. The radiation chemistry of some other alkyl cyanides was also investigated. Also a detailed study was made of the reactivity of acetonitrile with the trapped electron in γ-irradiated glasses of 2-Methyltetrahydrofuran. The irradiated systems were studied mainly by EPR spectroscopy, but some optical absorption experiments were performed. (TSS) (Diss. Abstr. Int., B)

48136 RADIOLYSIS OF LIQUID INORGANIC HYDROGEN COMPOUNDS. Bugaenko, Lenar Timofeewitsch (Lomonosov State Univ., Moscow). Z. Chem.; 8: 51-9(1968). (In German).

Basic principles of radiation effects on inorganic hydrogen compounds are outlined with respect to both reaction products and yields. A model for diffusion of ions is described. The detection and properties of radioinduced radicals, both reducing and oxidizing, are described. The dependence of radical formation on pH is discussed. Finally, reactions of radicals with substances in solution as well as with the solvent are considered. (48 references) (H.B.G.)

48137 RADIATION-INDUCED OXIDATION OF ETHANOL AND METHANOL BY HYDROGEN PEROXIDE IN AQUEOUS SOLUTION. Burchill, C. E.; Ginns, I. S. (Univ. of Manitoba, Winnipeg). Can. J. Chem.; 48: 2628-34(15 Aug 1970).

The radioinduced chain oxidation of ethanol and methanol by hydrogen peroxide in deaerated aqueous solutions was investigated. In each case the alcohol was oxidized to the corresponding aldehyde and hydrogen peroxide was reduced in equivalent yield. With ethanol as the oxidizable substrate the yields were independent of peroxide concentration in the range 5×10^{-2} to 5×10^{-3} M and linearly dependent on ethanol concentration in the range 0.085 to 0.85 M. In contrast, the oxidation of methanol was first order in hydrogen peroxide, independent of methanol concentration up to 2.0 M and showed a simple square root dependence on dose rate. The differences are explained by consideration of the participation of two different radicals derived from ethanol, CH_3CHOH and CH_3CH_2OH, whereas only one radical, CH_2OH, was formed from methanol. (auth) (Canada)

48138 RADIOTHERMAL RESISTANCE OF SOME ARYL SILANES. PART II. STUDY OF THE COMPOSITION HIGH-BOILING PRODUCTS OF HIGH-TEMPERATURE RADIOLYSIS OF SILANES. Burdasov, E. N.; Khramchenkov, V. A. This paper was summarized in At. Energ. (USSR); 25: 225-6(Sep 1968) as paper No. 228. (In Russian).

Studies were made on the composition of polymers produced by reactor radiolysis of $Si(CH_3)_2C_6H_5$ and $Si(CH_3)_2(C_6H_5)_2$ at high temperature. From the results, it was concluded that in the region of radiation cracking the formation of polymers by recombination of the radicals in the liquid phase is probable; in the region of radiothermal cracking, the formation of polymers is possible by a chain mechanism. Plots are given for the dependence of gas and polymer yields on the radiolysis temperature. (P.C.H.)

48139 RADIATION-INDUCED POLYMERIZATION OF STYRENE IN A RECIRCULATING FLOW REACTOR SYSTEM. Osborne, Franklin Talmage. Raleigh, N. C.; North Carolina State Univ. (1969). 187p. University Microfilms Order No. 70-9208.

Thesis.

A recirculating flow reactor system is used to study the radio-

induced polymerization of styrene. Monomer solution is recirculated from a stirred vessel through relatively long transfer lines to a tubular flow reactor positioned within a high-intensity ^{60}Co irradiator. A polymerization rate expression formulated from the literature is incorporated into a mathematical model for the conversion history in the system using engineering models for each of the flow elements. The performance of the system is simulated on the analog computer and analytical solutions obtained. The long-time analytical solution provides a simple relation between the polymerization rate and the time rate of change of conversion in the stirred vessel. Methods are described for removing both O_2 and moisture. Experimental results indicate that the pilot plant is an effective device for studying radiation induced polymerizations. In agreement with the mathematical model, the conversion in the vessel quickly becomes a linear function of time. The rate of free radical polymerization calculated from the conversion history using the mathematical model is in agreement with the anticipated value. The observed polymerization rates indicate purification procedures are adequate to obtain a significant level of ionic polymerization. Interpretation of the polymerization rate as the sum of a free radical contribution and an ionic contribution is justified in the light of observed experimental responses. (Diss. Abstr. Int., B)

48140 GAMMA-RADIATION-INDUCED EMULSION POLYMERIZATION OF STYRENE IN A RECIRCULATING FLOW REACTOR SYSTEM. Havewala, Noshir Behram. Raleigh, N. C.; North Carolina State Univ. (1969). 150p. University Microfilms Order No. 70-9232.

Thesis.

A recirculating flow reactor system was used to study the radioinduced emulsion polymerization of styrene. Emulsion was recirculated from a stirred vessel through transfer lines to a helical flow reactor positioned within a high intensity ^{60}Co irradiator. The pilot plant was equipped with an automatic temperature measurement and control system. Constructed from stainless steel tubings and fittings, the system was flexible enough to accommodate a wide range of experimental conditions. The experimental work included a study of a wide range of engineering operating conditions, such as flow rate and agitation rate; and a study of other important variables such as emulsifier concentration, monomer concentration, and temperature. Average molecular weights and particle size of the polymer, made under various conditions, and the effect of post-irradiation polymerization were also explored. Experimental findings indicated that the rate of polymerization increased substantially with increasing monomer concentration. The rate of polymerization and the average degree of polymerization increased with an increase in temperature. The activation energy, based on the rate and the average molecular weight, was found to be 1.6 kcal/mole and 1.1 kcal/mole, respectively. The rate of polymerization, per pass, was directly proportional to the exposure time but the over-all rate of polymerization increased with an increase in the recirculation rate, due to the prolonged zero order reaction period. The rate of polymerization increased with a decrease in agitation rate. A substantial post-irradiation effect was observed for the experiments carried out in the ampules under a vacuum of 10^{-5} torr. A mathematical model was derived and solved for the recirculating flow reactor system, and conversion histories of experimental runs, simulated analytically, were found to be in agreement with the mathematical model. (Diss. Abstr. Int., B)

48141 USE OF CARBON SUBOXIDE TO OBTAIN BLOCK AND GRAFT COPOLYMERS. II. GRAFTING OF CARBON SUBOXIDE ON POLYETHYLENE. Bukowski, Andrzej; Porejko, Stanislaw (Polytechnic Inst., Warsaw). J. Polym. Sci., Part A-1; 8: 2501-8(Sep 1970).

Experiments have been carried out on grating of carbon suboxide on nonactivated polyethylene films and on films previously activated by ultraviolet irradiation and by γ irradiation. The experiments gave a grafted copolymer. A grafted copolymer was also obtained on grafting carbon suboxide in solution on polyethylene films preactivated by means of ozonization at 70°C. Examination of the copolymer indicated its structure to be cross-linked. It has been proved that below 50°C single molecules of carbon suboxide react with polyethylene. The polyethylene thus modified is then easily surface-dyed. (auth)

48142 STUDY BY ESR OF THE FREE RADICALS IN IRRADIATED TETROXANE. Saito, E.; Cannavo, C.; Hayashi, K. (CEN de Saclay, Gif-sur-Yvette, France). J. Polym. Sci., Part A-1; 8: 2309-24(Sep 1970). (In French).

The free radicals induced in tetroxane at liquid nitrogen temperatures by ^{60}Co γ rays have been studied by ESR. The powder spectrum as well as the spectra of the single crystal rotated around the b axis have been studied through their modifications from −196°C up to +80°C. These spectra show that at low temperatures two radicals exist conserving the cyclic nature of the parent molecule. During the course of annealing, starting at −140°C and towards −85°C they are gradually replaced by radicals with a linear structure, this being the first step in the post-polymerication process of tetroxane. Further increase in temperature led to radical sites situated on the polymer chains. At low temperatures, evidence has also been found for the formyl radical, radical pairs, and a photosensitive radical. (auth)

Radiochemistry

Refer also to abstracts 48123 and 48874.

48143 (NP-18436) CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS: BIBLIOGRAPHY 1968. Adloff, J. P. (Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Recherches Nucleaires). 1968. 39p. (In several languages). Dep. CFSTI (U. S. Sales Only).

A 1968 bibliographical review on 227 alphabetic references is presented. A classified index of elements and isotopes and an alphabetic index of various authors' works are presented. (auth) (France)

48144 RADIOCHEMICAL INVESTIGATIONS ON PHTHALOCYANINATO ACTINIDE COMPLEXES. DETECTION OF THE BIS(PHTHALOCYANINATO) COMPLEXES OF PROTACTINIUM AND NEPTUNIUM. Lux, Franz; Ammentorp-Schmidt, Frtiz; Dempf, Dominik; Graw, Dieter; Hagenberg, Wolfgang (Technische Hochschule, Munich). Radiochim. Acta; 14: 57-61(Aug 1970). (In German).

The protactinium and neptunium bis(phthalocyaninato) Pc complexes, $^{233}PaPc_2$ and $^{239}NpPc_2$, were prepared from the corresponding thorium and uranium complexes $ThPc_2$ and UPc_2, by the element transformations (n,γ) (β^-) of ^{231}Th and ^{238}U, respectively. Their existence was proved by repeated sublimation of the irradiated parent compounds, showing that the specific activities of ^{233}Pa and ^{239}Np remain constant in the sublimates. $^{239}NpPc_2$ was also chemically synthesized on the tracer scale from irradiated uranium metal ($U + {}^{239}Np$) using the normal synthetic method for UPc_2, yielding ($UPc_2 + {}^{239}NpPc_2$). This experiment also indicated the possible existence of the hitherto unrecorded NpI_4. Improved experimental procedures are given for the preparation of $ThPc_2$ and UPc_2. (auth)

48145 LOW-TEMPERATURE VOLUME EXPANSION OF LiH:LiT. Dellin, Theodore Anthony. New York; City Univ. of New York (1969). 100p. University Microfilms Order No. 70-3401.

Thesis.

Crystals of LiH : LiT expand by self-damage due to the β decay of the T^-. At temperatures below 0°C the expansion is linear with the dose rate. Twenty-four defects in LiH : LiT were investigated theoretically. The formation energies of the defects and the relaxations of the ions surrounding some of the defects are presented. A model for the low temperature volume expansion is derived. The T^- ions undergo β decay to form He^+ atoms, which recoil and collide with Li^+ ions to produce interstitial Li^+. The Li^+ then captures an electron from the β decay to form Li^* or Li_2^+, which is sufficient to explain the observed volume expansion. (Diss. Abstr. Int., B)

Separation Processes

Refer also to abstracts 48041, 48064–48066, 48078, 48121, 48122, 48127, 48128, and 50117.

48146 (DOCKET-50201-45) WEST VALLEY REPROCESSING PLANT. Technical Specifications, Temporary Exception to Requirements Regarding Standby Blower Operability. (Division of Materials [and] Licensing (AEC), Washington, D. C.). 23 Sep 1970. 4p. Dep. CFSTI.

Authorization is given for temporary exception to the requirements of Technical Specification 5.3.3 regarding standby blower operability at the start of a campaign. (M.C.G.)

48147 (NLCO-1056) UNIRRADIATED FUEL ELEMENT PROCESSING FOR RECOVERY OF URANIUM OF VARIOUS ISOTOPIC VALUES. Morgan, G. J.; Podlipec, F. J. (National Lead Co. of Ohio, Cincinnati). Sep 1970. Contract AT(30-1)-1156. 21p. Dep. CFSTI.

Uranium was recovered from unirradiated scrap fuel elements in large-scale uranium production facilities at the AEC's Feed Materials Production Center. Special mechanical decladding and

chemical processing steps were developed for certain types of fuel elements. Included were unclad uranium metal shapes, thin-wall clad UO_2 fuel elements, Haliam (sodium-bonded UC) fuel elements, Experimental Gas-Cooled Reactor fuel, and aluminum-clad UO_2 rods. The ability to process a wide variety of fuel elements in quantities ranging from a few hundred pounds to tonnage lots was demonstrated at low costs and with minimal losses. Some of the materials processed served as feeds for a 2% ^{235}U uranium trioxide production order. Others became a part of mainstream production with uranium metal fuel cores for AEC reactors as the final product. (auth)

48148 (ORNL-4581, pp 62-9) ISOTOPE CHEMISTRY. (Oak Ridge National Lab., Tenn.).

From chemistry division annual progress report for period ending May 20, 1970.

Preliminary studies are underway in a search for a new method for the production of heavy water. A bench-scale pilot plant was constructed to aid in testing the CYANEX system for fractionation of carbon-12 and carbon-13. Raman spectra are reported for pure, molten Al_2Cl_6 and $AlCl_3$–NaCl at varying compositions. Raman spectra of solid and molten triphenylene were also observed. CO containing 60% ^{13}C was prepared by reducing isotopically enriched CO_2 over zinc at 400°C. (J.G.B.)

48149 (ORNL-TM-3124) THORIUM FUEL CYCLE DEVELOPMENT PROGRESS REPORT NO. 13, AUGUST 1970. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 18p. Dep. CFSTI.

Progress is reported on head-end processing development, refabrication development, TURF equipment design and engineering, and materials irradiation. (D.H.M.)

48150 (ORNL-tr-2390) RADIOCHEMICAL SEPARATIONS OF HAFNIUM, TANTALUM, AND GERMANIUM FROM TUNGSTEN AND SELENIUM IRRADIATED BY 14-MeV NEUTRONS. Blachot, Jean; Benabed, Abderrahmane; Herment, Jacques; Monnand, Edouard (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated by J. J. Pinajian (Oak Ridge National Lab., Tenn.), from report CEA-R-3678. 10p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 21775.

48151 EXTRACTION OF CURIUM AND EINSTEINIUM BY DIBUTYL,N,N,DIETHYL CARBAMYL PHOSPHONATE (DBDECP) FROM MINERAL ACIDS. Aly, H. F. (Atomic Energy Establishment, Inshas, Egypt); Latimer, R. M. J. Inorg. Nucl. Chem.; 32: 3081-9(Sep 1970).

The extraction of curium and einsteinium by dibutyl,N,N,diethyl carbamyl phosphonate (DBDECP) from nitric, hydrochloric, and perchloric acid solutions was studied. A trisolvate was formed with the extracted species. A reaction mechanism is suggested in which the extracted complex takes the form $MA_3(DBDECP)_3$ and/or MA_4^{-1} ..... $^{+}H_3O(DBDECP)_3$. (auth) (UK)

48152 STUDIES ON THE CATION-EXCHANGE BEHAVIOR OF AMMONIUM 12-MOLYBDOPHOSPHATE. PART I. SEPARATION OF RUBIDIUM, THALLIUM, AND CAESIUM. Dutta Roy, S.; Sankar Das, M. (Bhabha Atomic Research Centre, Trombay, India). Anal. Chim. Acta; 51: 509-15(Sep 1970).

The cation-exchange behavior of ammonium 12-molybdophosphate (AMP) for thallium (I) is discussed. Conditions are described for the separation of rubidium, thallium, and cesium from one another on a column of AMP suitably mixed with asbestos. The three elements are adsorbed from 5 M nitric acid. Rubidium is first eluted with 3 M ammonium nitrate. Thallium is separated by oxidative elution using bromide–bromine mixture. Cesium is finally removed by 12 M ammonium nitrate. (auth)

48153 THORIUM HYDROXIDE AS A COLLECTOR OF MOLYBDENUM FROM SEA WATER. Kim, Young S.; Zeitlin, Harry (Univ. of Hawaii, Honolulu). Anal. Chim. Acta; 51: 516-19 (Sep 1970).

Studies were made on the use of thorium hydroxide as a collector of the trace element Mo from seawater before its spectrophotometric determination as the thiocyanate complex. This collector offers advantages over $Fe(OH)_3$, such as enhanced sensitivity, accuracy, and elimination of the need for masking Fe(III) since thorium ion does not react with thiocyanate. The $Th(OH)_4$ coprecipitate, also, is less bulky than $Fe(OH)_3$ and easier to handle and filter. The use of $Al(OH)_3$ as a collector was also investigated for comparative purposes. At the optimal pH for collection, maximum recovery was obtained with $Th(OH)_4$. Recovery with $Fe(OH)_3$ was slightly less, and that from $Al(OH)_3$ was below 10%. The results also showed that additional metallic trace anionic species may be coprecipitated along with Mo by $Th(OH)_4$ from seawater. Efforts to identify and develop appropriate procedures for their separation and determination are underway. (P.C.H.)

48154 ANION EXCHANGE BEHAVIOUR AND SEPARATION OF THORIUM, PROTACTINIUM, AND URANIUM IN NITRIC ACID AND ACETIC ACID MIXTURES. Kim, J. I.; Born, H.-J. (Inst. for Radiochemistry, Munich). Radiochim. Acta; 14: 65-70(Aug 1970).

The anion exchange behavior of thorium, protactinium, and uranium was studied with Dowex 1 × 8 (100 to 200 mesh; nitrate form) in various mixtures of acids, varying from pure nitric acid to 90% acetic acid and 10% nitric acid (vol/vol) while changing the nitric acid concentrations from 1 to 14 N within its volume rate. Adsorptions of the elements were greatly enhanced in mixed media compared with pure aqueous nitric acid system, increasing with increasing acetic acid concentration. Increases of the distribution coefficients depending on nitric acid as well as acetic acid concentration differed largely following the order: thorium > protactinium > uranium, resulting in large separation factors, e.g., 1411 and 29 for thorium and protactinium relative to uranium in 90% acetic acid and 10% 14 N nitric acid. Application of this mixed system thus provided an easy separation of these three elements from one another to any desired degree of concentrations. By adsorption of the elements in the feeding solution containing a small amount of hydrofluoric acid, in which protactinium remains stable, a satisfactory separation was accomplished. (auth)

48155 SEPARATION OF SHORT-LIVED RADIONUCLIDES BY USE OF THE RECOIL EFFECT. Mundschenk, H. (Univ., Mainz). Radiochim. Acta; 14: 72-7(Aug 1970). (In German).

A fully mechanized apparatus, which is described, can be used for continuous separation of short-lived radionuclides out of a complex mixture of nuclides using the recoil effect. The applicability of the method is described by the determination of half-life of recoil nuclei produced in an α-(^{200}Tl) and a β-transition (^{211}Bi), respectively. In addition, the apparatus can be used for studies of interface phenomena. Thus, the aging process of ^{211}Pb on a Pt backing was followed continuously and the respective constants were determined with a relatively high accuracy. Also, the method mentioned was used in investigations on the charge and energy distribution of the recoil nuclei. (auth)

48156 RADIOCHEMICAL PROCEDURE FOR ARSENIC AND GERMANIUM. Ward, T. E.; Swindle, D. L.; Wright, R. J.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Radiochim. Acta; 14: 70-2(Aug 1970).

A radiochemical procedure is given for the separation of radioactive arsenic and germanium from mixed fission products of thorium and uranium. The basis of decontamination is extraction of As^{3+} and Ge^{4+} into CCl_4 from ≥10 N HCl solutions. Decontamination factors of 3×10^7 and chemical yields of about 30% were determined for As and Ge. (auth)

48157 ELUTION CHROMATOGRAPHY OF RARE EARTHS AT HIGH FLOW RATES. Riccato, Maria Teresa; Herman, Guenter (Univ., Mainz). Radiochim. Acta; 14: 107-8(Aug 1970). (In German).

Elution chromatography of rare earths using bis(2-ethylhexyl) orthophosphate as the stationary phase and HCl as the mobile phase was studied with mixtures and individual rare earths. Different flow rates were compared. (M.C.G.)

48158 USE OF TRILAURYLAMINE IN THE PROCESS FOR PURIFICATION OF NEPTUNIUM. I. STUDIES ON THE COEXTRACTION OF NEPTUNIUM AND PLUTONIUM. Gourisse, D.; Bathellier, A. (CEA-CEN, Fontenay-aux-Roses, France). Radiochim. Acta; 13: 187-91(Jun 1970). (In French).

A countercurrent process of tetravalent neptunium and plutonium extraction from 3.5M HNO_3 solution by trilaurylamine (20%) in dodecane was studied. This process is valid for recovery of both elements from the highly radioactive wastes of the irradiated fuel processing plants. Valence adjustment is obtained by adding hydrazine nitrate (0.05M) and the stoichiometric quantity of uranous nitrate required for neptunium reduction. The neptunium extraction yield is greater than 99.99% in 7 stages. Plutonium is slowly reduced to the trivalent state. (auth)

48159 USE OF TRILAURYLAMINE IN THE PROCESS FOR PURIFICATION OF NEPTUNIUM. II. STUDIES ON THE NEPTUNIUM–PLUTONIUM SEPARATION. Gourisse, D.; Bathellier, A. (CEA-CEN, Fontenay-aux-Roses, France). Radiochim. Acta; 13: 191-5(Jun 1970). (In French).

A study of neptunium–plutonium separation by selective trilaurylamine (TLA) extraction of neptunium shows that scrubbing with a reducing solution in dilute nitric acid medium is ineffec-

tive. Decontamination from plutonium is well improved by introducing sulfuric acid in the reducing scrub solution, the plutonium reduction being much faster. A separation scheme in which decontamination factor from plutonium is $>4 \cdot 10^3$ was developed. A neptunium–plutonium partition flowsheet from a loaded TLA solution was also designed. Flowsheets are suggested for neptunium recovery from irradiated fuels processing plant wastes and for chemical processing of irradiated neptunium-237. (auth)

48160 EXTRACTION OF URANYL NITRATE BY ALIPHATIC SULFOXIDES. Laurence, Guy (ENSCP, Paris). J. Inorg. Nucl. Chem.; 32: 3065-71(Sep 1970). (In French).

It was demonstrated that diheptyl and dioctyl sulfoxides could extract uranyl nitrate with a good yield, by formation of $UO_2(NO_3)_2 \cdot 2$ sulfoxides-type complex. With light sulfoxides this complex had a low solubility in the diluant used (carbon tetrachloride) and precipitated. Nitric acid in the aqueous phase promoted extraction. This salting out effect reached a maximum for a 4.5N acid concentration. It was also demonstrated that for high concentrations the uranyl nitrate distribution coefficient was proportional to the initial sulfoxide concentration. (auth) (UK)

48161 PERMEABILITY SEPARATORY CELL AND APPARATUS AND METHOD OF USING THE SAME. (to Dow Chemical Co.). British Patent 1,203,655. 3 Sep 1970. Filed 30 Aug 1967.

A reverse osmosis apparatus and processes for separating a component of multicomponent fluids, including uranium and other rare salts from leach liquors, and the processing of radioactive wastes are described. An improved and very efficient permeability separatory cell is described; the separatory membrane is a synthetic polymer material made up of interlaced hollow fibres in meshed form. Both anionic and cationic materials are used. Constructional details are given. (UK)

48162 EXTRACTION OF MOLYBDENUM(VI) WITH ANILINE FROM HYDROCHLORIC ACID SOLUTIONS. Fischer, Claus; Muehl, Peter; Guenzler, Gert (Institut fuer Metallphysik und Reinstmetalle, Dresden). Z. Chem.; 8: 235-6(1968). (In German).

Mo(VI) can be easily extracted from a hydrochloric acid solution by means of aniline. If the ratio of hydrochloric acid/molybdenum equals 2, the molybdenum appears as $(C_6H_5NH_3)_2\ MoO_4$. If the ratio increases, the product appears as $(C_6H_5NH_3)_2\ MoO_7O_{24}$. Transition of molybdate from monomer to heptamer occurs approximately at a ratio of 2.5. (H.B.G.)

48163 PURIFICATION OF TRANSPLUTONIUM ELEMENTS. Koehly, Gerard (to Commissariat a l'Energie Atomique). British Patent 1,205,736. 16 Sep 1970. Priority date 29 Mar 1968, France.

A method of separating transplutonium elements from aqueous solutions, also containing rare earth elements and fission products, consists of extracting the fission products from the aqueous phase adjusted to ≥1 N acidity with bis(2-ethylhexyl) phosphate in organic solution. The rare earth and transplutonium elements remain in the aqueous phase for further purification. (B.L.M.)

48164 ANION EXCHANGE BEHAVIOUR OF THORIUM, PROTACTINIUM, URANIUM, AND OTHER ELEMENTS IN HYDROCHLORIC ACID AND ACETIC ACID MIXTURE. Kim, J. I.; Born, H.-J. (Inst. for Radiochemistry, Garching, Ger.). Radiochim. Acta; 14: 35-9(1970).

The anion exchange behavior of thorium, protactinium, uranium, and other elements representing the alkali, the alkaline earth and the rare earth group was investigated under various conditions of hydrochloric acid and acetic acid mixture compositions. Adsorption measurements were made at room temperature with the solution composition varying from pure aqueous hydrochloric acid to 90% acetic acid and 10% hydrochloric acid, also changing the acidity of the latter from 1N to 12N within its volume rate of the total solution. The possibility of a simultaneous separation of thorium, protactinium, and uranium, also from other elements, was demonstrated. (auth)

48165 EXTRACTION OF TRANSPLUTONIUM ELEMENTS BY DI-2-ETHYLHEXYLPHOSPHORIC ACID. I. STABILITY CONSTANTS OF CURIUM, BERKELIUM, CALIFORNIUM, AND EINSTEINIUM WITH SOME HYDROXYCARBOXYLIC ACIDS. Aly, H. F.; Latimer, R. M. (Atomic Energy Establishment, Cairo). Radiochim. Acta; 14: 27-31(1970).

The extraction of the transplutonium elements Cm, Bk, Cf, and Es into bis(2-ethylhexyl)phosphate (D2EHPA) from aqueous solutions containing the hydroxycarboxylic acids; 2-methyllactic, citric, tartaric, and malic acids was studied. The stability constants for the complexes formed between the hydroxycarboxylic acids and the actinide elements were determined. Sufficient differences in the extractability of the elements investigated showed they could be separated from each other using an extraction chromatographic column of D2EHPA and elution with 2-methyllactic acid. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 48291, 48304, 48314, and 48334.

48166 (UCRL-Trans-10483) IMPORTANCE OF GROUND-WATER HELIUM SATURATION IN OIL AND GAS PROSPECTING. THE NATURE OF THIS PHENOMENON IN THE DNIEPER-DONETS BASIN. Gutsalo, L. K. Translated by B. Thayne for Univ. of California, Lawrence Radiation Lab., Livermore, from Izv. Akad. Nauk SSSR, Ser. Geol.; 31: No. 9, 111-16(1966). 17p. Dep. CFSTI.

The use of He as a hydrochemical index in gas and petroleum prospecting was investigated on the basis of available information on He distribution in the ground water of the Dnieper-Donets Basin. Measurements were made of the helium content in ground waters from 14 areas of the basin, and gave detailed data on both the horizontal and vertical distribution of helium saturation of the ground water in different water-bearing complexes. The influence of petroleum and gas deposits on the character of helium distribution in the water in contact with them was ascertained. Comparison of the data showed that: in strata waters, the He accumulation from the natural He background exhibits a straight linear dependence on the degree of the water's mineralization; the He accumulation in ground water is determined mainly by the concentration of soluble radium salts in the water and by the age of the water-containing rocks; there are positive He anomalies in ground waters around petroleum and gas deposits; the He anomalies in ground waters around these deposits arise due to corresponding positive radium anomalies in the waters; and the relative helium saturation of the ground water can serve as an indicator of the presence of underground gas or petroleum. Therefore, He determinations should be included in tests used in gas and petroleum prospecting. (L.C.L.)

48167 ERASURE OF FISSION TRACKS IN GLASSES AND SILICATES BY SHOCK WAVES. Ahrens, Thomas J. (California Inst. of Tech., Pasadena); Fleischer, Robert L.; Price, P. Buford; Woods, Richard T. Earth Planet. Sci. Lett.; 8: 420-6(Jul 1970).

Shock-loading experiments were carried out to determine the effect of dynamic pressures and associated temperatures on fission tracks in tektite (indochinite) and soda-lime glasses, biotite, and apatite. Below shock pressures of 83 ± 4 and 31 ± 3 kb, track densities remain unaltered in the tektite and soda-lime glass, respectively. In the tektite glass, partial and complete erasure of tracks is observed in samples recovered from 112 ± 2 and 133 ± 10 kb. In the soda-lime glass, partial erasure is observed in samples recovered from 33 ± 3 and 42 ± 3 kb. Shock temperature calculations indicate that the temperatures achieved upon shocking the glasses are appreciably lower than those at which tracks would be annealed out under static conditions. Single crystals of apatite retain tracks when shocked to 45 ± 5 kb. Apatite recovered from shock pressures above 82 ± 5 kb is granulated to micron-sized particles which preclude recognition of tracks. Single-crystal biotite specimens shocked to pressures up to 173 ± 5 kb show no appreciable loss in fission track density. (auth)

48168 EVALUATION OF THE EFFECT OF THE INCIDENCE ANGLE OF THE BOREHOLE WITH THE ORE LAYER ON THE RESULTS OF THE DIFFERENTIAL INTERPRETATION OF γ-LOGGING DATA. Zimin, D. F.; Borzyak, I. P. (Inst. for Geological Explorations, Moscow). Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; 13: 106-10(1970). (In Russian).

The various differential interpretation techniques of γ-logging data are based on the assumption that the seams lie at a right angle with respect to the direction of the beamhole. This is not always the case; therefore, the error due to the deviation from the rectangular correlation was examined. The observed γ-radiation intensity at any point on the axis of the borehole depends on the amount of ore included within the sphere, the center of which coincides with the point of observation, while its radius is the same as the radius of saturation. The usual interpretation does not yield the correct value. Calculations were made to obtain the required correction, presenting the results in the form of a nomogram. It is recommended that the effect due to the incidence angle between the borehole and the seam always be taken into account when the differential interpretation technique is employed. (TTT)

48169 POTENTIAL USE OF NEUTRON-γ LOGGING TO CONTROL THE EXPLOITATION OF NATURAL GAS DEPOSITS. Berman, L. B.; Dvorkin, L. B. Razved. Geofiz.; 34: 117-26(1969) (In Russian).

Control of the operation of natural gas deposits or underground gas storage reservoirs makes it necessary to check the changes of the saturation level of gas in the deposits. This can be done conveniently by neutron γ logging. It was found that the currently used calculation of the saturation level and obtainment of the original data lead to erroneous results. The accuracy may be substantially improved by making use of neutron γ logging diagrams based on data recorded in the same borehole at different times. Comparison of the first measurements with subsequent ones helps to determine the relative changes of the indices with respect to the control layers, thus allowing changes in their level of saturation with gas to be determined, as their porosity remains unchanged. The neutron γ logging diagrams may be obtained by the correlation transformation method. (TTT)

48170 STRONTIUM AND URANIUM CONCENTRATIONS IN ARAGONITE PRECIPITATED BY SOME MODERN CORALS. Thompson, G.; Livingston, H. D. (Woods Hole Oceanographic Institution, Mass.). Earth Planet. Sci. Lett.; 8: 439-42(Jul 1970).

Ahermatypic corals, and hermatypic corals without zooxanthellae, have Sr and U concentrations that are greater than those of reef corals containing zooxanthellae. The Sr and U concentrations in the corals are independent of water temperature, in that respect differing from those in aragonite experimentally precipitated from seawater in the laboratory. The deposition of Sr and U in scleractinian coral aragonite may be related to coral metabolic processes and to the influence of algal photosynthesis on calcification rates. (auth)

48171 CORRECTIONS FOR INTERFERING ISOTOPES IN THE $^{40}Ar/^{39}Ar$ DATING METHOD. Brereton, N. R. (Cambridge Univ., Eng.). Earth Planet. Sci. Lett.; 8: 427-33(Jul 1970).

The principal limitation of the ^{39}Ar, ^{40}Ar dating method is the presence of calcium in the sample which produces interfering argon isotopes during neutron irradiation. The extent of interference on the potassium-argon age is primarily a function of the age and the calcium concentration. High calcium concentrations can be tolerated (30 to 40%) for samples with ages more than 1000 Myr, but for samples with ages of a few million years, significant errors are produced by less than 1% calcium. In addition, for young samples, interfering argon isotopes produced from potassium during neutron irradiation also give rise to errors. An expression is derived which eliminates the effects of the interfering isotopes, and an indication of the degree of interference is given. The relative amounts of argon isotopes, produced during irradiation, are also shown. (auth)

48172 SOLUTION OF THE DIRECT PROBLEM FOR THE γ-RADIATION INTENSITY GRADIENT IN A BOREHOLE. Davydov, Yu. B. (Sverdlovsk Mining Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Gorn. Zh.; 12: No. 4, 3-6(1969). (In Russian).

Methods for measuring the γ-radiation intensity of boreholes passing through radioactive layers were studied. It was assumed that the absorption of the γ radiation in the medium is defined by the linear absorption coefficient which is constant for a given medium, and the additivity law applies. The γ field gradient data may be obtained by direct measurements in the beamhole or by recalculating the data contained in γ logging curves. The results of the calculation may be used to interpret the gradient curves. (TTT)

48173 DIRECT ESTIMATION METHOD OF RADIOACTIVE CONTAMINATION ON GROUND SURFACE IN EMERGENCY SITUATIONS. Moriuchi, Shigeru (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri; 5: No. 2, 55-61(Jun 1970). (In Japanese).

In emergency surveys, exposure dose-rate-responding detectors were generally used for estimating ground surface contamination in Ci/km^2. However, the process of estimating the deposited radioactivity by exposure dose rate measurements is inaccurate due to the large photon energy dependence of dose rate-to-photon flux conversion. Therefore, this estimation method is useful only for the simple release of one or two radioisotopes to the environment. On the other hand, photon flux at a given height above ground is directly related to the disintegration rate of radioisotopes on the ground surface. Therefore, the use of a NaK(Tl) scintillation counter as a photon flux responding detector, instead of the exposure rate responding detector for environmental surveys, is discussed. It is proven that this method for estimating the ground surface contamination directly from the counting rate in cpsec is superior to the former method in both accuracy and simplicity. (auth) (Japan)

48174 RARE EARTH ABUNDANCES IN SEVERAL GEOCHEMICAL STANDARD ROCKS. Higuchi, Hideo (Rikkyo Univ., Yokosuka, Japan); Tomura, Kenji; Onuma, Naoki; Hamaguchi, Hiroshi. Geochem. J. (Nagoya); 3: 171-80(Dec 1969).

Concentrations of rare earth elements in eight U. S. Geological Survey standard rocks, G-1, W-1, G-2, GSP-1, AGV-1, BCR-1, PCC-1 and DTS-1 are reported. The rare earth elements were determined by neutron activation analysis with a lithium-drifted germanium detector after chemical group separation. Rare earth abundance data in PCC-1 and DTS-1 are the first available on these rocks. (auth) (Japan)

48175 MEASUREMENT OF ROCK DENSITY AND PROSPECTING FOR HEAVY METALLIC ORE DEPOSITS BY USING GAMMA-GAMMA LOGGING. Nakai, Junji (Geological Survey of Japan, Kawasaki). Butsuri Tanko; 22: No. 4, 190-204(Sep 1969). (In Japanese).

A one group diffusion equation was applied to the transmission of gamma radiation from a point source in a finite continuous media, and gamma flux as a function of distance from the source was derived. On the assumption that the intensity of the scattered gamma radiation recorded by a logging instrument is proportional to gamma flux, a few characteristics of gamma-gamma density logging, such as a dependence of response on the rock density, source-detector separation, and primary energy were investigated. The comparisons of these diffusion solutions with results in the field are presented and each characteristic affirmed. The basis of gamma-gamma density logging is that the intensity of Compton scattering gamma radiation by light elements in the rock is measured, and therefore the recorded intensity depends only upon the density of the rock and is independent of chemical composition. With a low concentration of heavy elements of high atomic number, the intensity of scattered gamma radiation is decreased as a result of photoabsorption, and when the primary energy is lower, the decrease is more remarkable. If heavy metallic ore deposits are assumed to be composed of nonmetallic rocks consisting of light elements and low concentrations of heavy metal elements, the detection of the latter is facilitated by measuring the intensity of scattered gamma radiation. Selenium-75 was selected as a suitable source and the gamma fluxes in metal ore deposits for a point source were numerically calculated according to the diffusion equations and measured experimentally. Variation in density of rock restricts the detection of metal elements and the limitation was examined. (auth) (Japan)

48176 THERMOLUMINESCENCE DATING APPLIED TO VOLCANIC LAVA. Hwang, F. S. W. (Birmingham Univ., Eng.). Nature (London); 227: 940-1(29 Aug 1970).

Reference is made to earlier studies by Aitken et al. in this field, when a spurious glow was observed, that was attributed to impurities difficult to separate from the luminescent grains using magnetic separators. A new approach to the technique of volcanic rock dating was used by selecting crystalline grains from a rock for measurement of thermoluminescence. Volcanic ash believed to have come from Pompeii was examined. The heating rate used was 20°C/sec, in an atmosphere of N_2, and for dating purposes the total glow in the temperature region 320 to 420°C was chosen, using the ordinate ratio test technique. The ratio of the natural glow to the artificial glow at the same temperature was plotted against the heating temperature. The age determination was based on the assumption that the β- and γ-particles have the same effectiveness in inducing thermoluminescence, and in view of the size of the grains the dose contributed by α-particles was considered insignificant. The thermoluminescence age of this ash was calculated as 1797 ± 160 years. Lavas collected from the upper slope of Vesuvius were also investigated, and these appeared to be young. (UK)

48177 PHOSPHORITE PROSPECTING USING A SUBMERSIBLE SCINTILLATION COUNTER. Summerhayes, C. P. (Imperial Coll. of Science and Tech., London); Hazelhoff-Roelfzema, B. H.; Tooms, J. S.; Smith, D. B. Econ. Geol.; 65: 718-23 (Sep-Oct 1970).

Following successful experiments demonstrating that radioactivity measurements on samples can be used as a guide to their phosphate content, preliminary trials have been made on the application of a submersible scintillation counter as a prospecting tool. The results have been sufficiently encouraging to warrant the development of towed continuously recording equipment. (auth)

Meteorology

Refer also to abstracts 48456, 48463, 48464, 48469, and 48552.

48178 (BNWL-1307(Pt.2), pp 14-16) IN-CLOUD SCAVENGING. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

The identification of cloud processes which are instrumental in transferring and removing airborne contaminants into or from the precipitation elements, requires studies of the in-cloud and total wet removal of airborne contaminants. (auth)

48179 (BNWL-1307(Pt.2), pp 20-7) RADIOACTIVE FALLOUT RATES AND MECHANISMS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

Studies of the meteorological, chemical, and radiochemical compositions of atmospheric aerosols from ground level to maximum attainable altitudes are being made to determine the rates and mechanisms by which airborne radionuclides become attached to the aerosol, the origin and chemistry of the host aerosol, and the rates and mechanisms of mixing and scavenging processes in the atmosphere. (auth)

48180 (IITRI-C-6105-10) SCAVENGING STUDY OF SNOW AND ICE CRYSTALS. Quarterly Progress Report, November 1969-January 31, 1970. Sood, Sudesh K.; Jackson, Meryl R. (IIT Research Inst., Chicago, Ill.). 15 Jan 1970. Contract AT(11-1)-578. 25p. Dep. CFSTI.

Scavenging efficiency of naturally precipitating snow and ice crystals for 0.563 μ latex singlets and doublets has been studied. The effect of crystal habit and size on scavenging efficiency has been determined using an electron microscope. Charge measurements on snow and ice crystals were continued. (auth)

48181 (IITRI-C-6105-12) SCAVENGING STUDY OF SNOW AND ICE CRYSTALS. Quarterly Progress Report, May 1-July 31, 1970. Sood, Sudesh K. (IIT Research Inst., Chicago, Ill.). 10 Aug 1970. Contract AT(11-1)-578. 18p. Dep. CFSTI.

The experimental equipment which has been assembled and used successfully to grow ice crystals by water vapor condensation is described. A theoretical analysis of the capture of aerosol particles by growing ice crystals has been made. Reasonable agreement has been found to exist between theoretical predictions and the experimental data in the literature. (auth)

48182 DEVICE FOR CONTINUOUSLY RECORDING ATMOSPHERIC RADIOACTIVITY. Matulyavichyus, V. P. Meas. Tech. (USSR) (Engl. Transl.); No. 3, 479-80(Mar 1970).

Translated from Izmer. Tekh.; No. 3, 100-1(Mar 1970).

An aspiration method is used to draw air through filtering materials. The filter is in the form of a tape which is pulled past an intake opening. The gas flow rate and the rate of tape movement are kept about constant. A tape transport is included along with an integrating radiometer and automatic recorder. (J.R.D.)

48183 PERIODIC CHANGES IN THE CONCENTRATION OF THE NATURAL RADIONUCLIDES, RESULTANT PRODUCTS OF RADON, IN THE LOWER TROPOSPHERE. Kopcewicz, Teodor (Univ., Warsaw). Z. Meteorol.; 21: No. 3/4, 65-87(1969). (In German).

The types of natural radionuclides, the resulting products of radon and thoron, are described in general along with a consideration of their distribution in the atmosphere and the various forms of balance of the stratification of the air mass. Results of the continuous records of β-activity of the natural radionuclides from 1965 to 1966 at the Warsaw station and the calculated average hourly values of this activity provide a discussion of the periodic changes—diurnal and annual. The influence of a number of meteorological parameters, such as continuous precipitation and fog, upon the diurnal variation of the activity is examined. The influence of the types of air mass upon the time development of the activity of the radionuclides in Warsaw was studied. Some examples are given with a detailed description of the development of meteorological conditions and the most significant synoptic situations. The discussion includes the influence of the aging process of polar-maritime air masses upon the time variations of the activities. (Meteorol. Geoastrophys. Abstr.)

48184 INTERACTION BETWEEN RADIOACTIVE IONS AND CONDENSATION NUCLEI. Kawano, Minoru; Ikebe, Yukimasa; Nakayama, Takeyoshi; Shimizu, Kuniyasu (Nagoya Univ., Japan). J. Meteorol. Soc. Jap.; 48: No. 1, 69-76(Feb 1970).

To clarify the interaction between radioactive ions and condensation nuclei, simultaneous measurements of the concentrations of radioactive ions, radioactive aerosols, condensation nuclei, and small positive ions were carried out on the top of Mt. Norikura and the campus of Nagoya University. The mean life of radioactive ions is 38 sec on the top and 14 sec on the campus, respectively. The concentration of radioactive ions

correlates positively with that of small positive ions and negatively with that of condensation nuclei. These correlations may be well expressed by the following simple formulae; $q = \beta n Z$ and $q_0 = \beta_0 n_0 Z$. (auth) (Japan)

48185 RADIOACTIVITY OF RAINDROPS. Avramenko, A. S.; Makhon'ko, K. P. Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana; 5: 647-8(Jun 1969). (In Russian).

The role of evaporation in the distribution of specific radioactivity in raindrops was studied experimentally using specially prepared samples of radioactive drops which were identical to drops in the upper atmosphere. The experiments took place in the summer of 1967 in the northern Caucasus. Radar measurements at the moment of rainfall showed that the lower level of cloudiness was approximately 1.6 km above ground level. The upper level was at 3.4 km. The results of the measurements of specific radioactivity of the drops as a function of radius are presented graphically and showed an increase in specific radioactivity with an increase in radius. An increase in concentration of radioactive Rn and Th decay products in small drops was observed at ground level and was the result of partial evaporation of the drops during fallout. Data obtained showed that the difference in specific radioactivity of raindrops develops during condensation in the clouds. (tr-auth)

48186 MEASUREMENTS OF ARTIFICIAL RADIOACTIVITY IN THE FREE ATMOSPHERE FROM AIRCRAFT. Fischer, Hans Friedrich (Versuchsanstalt fuer Luftund Raumfahrt e.V., Oberpfaffenhofen, Ger.). Ann. Meteorol.; No. 4, 126-31(1969). (In German).

A number of measuring flights were performed to explore radioactivity in the free atmosphere descending from nuclear weapon tests. Radioactive aerosols were collected on fiber filters; after landing the samples were examined using a low-level counter for β-activity and using a scintillation counter with a NaI-crystal for γ-activity. The β-disintegration curves were recorded for an extended time and the energy distribution of γ-radiation was measured. Specific β-activity in the explored altitudes, fraction of fresh debris to total amount of the activity, and the compound respecting to isotopes were found out. Flowrate during the filter-exposition, collection efficiency and self-absorption in the filter were especially analyzed. The method and problem of collecting aerosols using aircraft, operations of the equipment developed for this and essential principles of analysis of the records obtained are described. Results of measurements on the occasion of the Chinese nuclear weapon tests are mentioned. (Meteorol. Geoastrophys. Abstr.)

48187 FALLOUT OVER TAIWAN FROM NUCLEAR WEAPON TESTS AT LOP NOR AND SIBERIA (1958–1969). Weng, P. S. (National Tsing Hua Univ., Hsinchu, Taiwan); Tsai, C. M.; Cheng, C. H. Health Phys.; 19: 563-9(Oct 1970).

Measurements of airborne and deposited fallout over Taiwan, resulting from the nuclear tests at Lop Nor and Siberia during 1958 through 1969, are reported and discussed. (auth) (UK)

48188 SELF-PURIFICATION OF THE ATMOSPHERE. PART 6. ATMOSPHERIC RADIOACTIVITY DURING 1965–67). Cauwenberghe, A. R.; Van Wichelen, S. Natuurwetensch. Tijdschr. (Ghent); 50: 192-204(1968). (In Dutch).

During 1965 to 67 natural atmospheric β-activity was measured. A statistical model was established, by which the considerable changes in natural radioactivity could be related to the variations of some meteorological variables, such as the wind direction and velocity, rainfall, temperature, pressure and humidity and the degree of blackness of the paper filter through which the air was filtered. A complete fit could not be obtained. Correlation matrix revealed some remarkable trends of the variables. A definite dependence on the degree of cloudiness and wind direction was found. (Meteorol. Geoastrophys. Abstr.).

48189 CONCENTRATION OF URANIUM IN AIR FROM CONTRASTED NATURAL ENVIRONMENTS. Hamilton, E. I. (Radiological Protection Service, Sutton, Eng.). Health Phys.; 19: 511-20(Oct 1970).

The concentration of uranium in the air was determined by the fission track method, using polycarbonate detectors, from two contrasted natural environments, namely, the Radiological Protection Service site at Sutton, U. K., and during an ocean traverse from Belgium to Antarctica. A modal concentration of 20×10^{-12} g U/m^3 air and 45 μg of dust/m^3 air was obtained for the Sutton site which is equivalent to a modal concentration of 0.4 ppM U in the air particulate matter. A mean concentration of 4.1×10^{-12} μg U/m^3 air was obtained for Atlantic Ocean air sampled in the Northern Hemisphere; in the Southern Hemisphere, no uranium was detected in many of the samples, but a mean concentration of 3×10^{-12} g U/m^3 air was obtained for air sampled on the land mass of Antarctica. Various sources are considered to account for the presence of uranium in the air. A correlation between the periodicity of fission products in the air and the concentration of uranium is noted. It is concluded that uranium present in the air at a particular site consists of local debris, together with distant debris transported as a result of world wide meteorological conditions. (auth) (UK)

Mineralogy and Exploration

Refer also to abstract 48874.

48190 (AEC-tr-7180) URANIUM DEPOSITS IN SEDIMENTARY BASINS STUDIED BY THE CEA. Gangloff, A. (Commissariat a l'Energie Atomique, Paris (France)). Translation of a French article. 24p. Dep. CFSTI.

Uranium deposits in sedimentary deposits of the Agades Basin (Niger), the Franceville Basin (Gabon), Herault Basin (France), and the Bakouma region (Central African Republic) were studied. Data on the geological characteristics and types of sedimentation in each area are presented. Some general characteristics of U deposits in continental clastic sediments, such as the Agades, Franceville, and Herault basins, and the genesis of these deposits are described. The unusual characteristics of the Bakouma uraniferous deposit are discussed. (L.C.L.)

48191 RESPECTIVE BEHAVIOR OF URANIUM, THE THORIUM GROUP AND THE TIN GROUP IN THE GRANITE DEVELOPMENT PROCESS (EXAMPLES TAKEN FROM THE NORTH LIMOUSIN GRANITES). Ranchin, Guy (Nancy Univ.). Compt. Rend., Ser. D; 270: 2748-51(8 Jun 1970). (In French).

Its manner of occurrence and its evolutive behavior distinguish uranium from thorium, zirconium, and the rare earths. The affinities connecting uranium with the tin group demonstrate that its behavior is governed by the crystallo-chemical properties corresponding to the hexavalent state. The part played by the oxidation of uranium when the differentiation occurs is thus emphasized. (auth) (France)

48192 PECULIARITIES OF THE ORE FORMATION PROCESS IN URANIUM DEPOSITS OF STRATUM OXYGEN ZONALITY. Bulatov, S. G.; Shchetochkin, V. N. Sov. Geol.; No. 4, 110-19 (Apr 1970). (In Russian).

Mineralization and epigenetic changes in ore-bearing rock and deposits of the oxygenic bed zonality were examined. Two separate types of epigenetic variations (oxygenic and bituminous carbonate) produced by the action of infiltrating oxygenic waters and escaping thermal solutions with reducing properties were found. The spatial and date ratios were used for determining the development and reactions of the above processes and the place and time of ore formation stages. The new theories on the mechanism of formation of mineralization lead to more accurate prospecting and exploration criteria. (tr-auth) (INIS)

Oceanography

Refer also to abstract 48047, 48051, and 48456.

48193 (BNWL-1307(Pt.2), pp 8-10) PHYSICAL AND RADIOLOGICAL CHEMISTRY OF OCEAN SOLUTIONS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

The rates and mechanisms of the chemical and mixing processes in the ocean are being investigated by use of the ocean's natural elemental and radionuclide tracers. These studies as a function of depth over wide areas of the ocean are allowing the determination of factors governing vertical diffusion and the determination of oceanographic pollutant concentrations and their pathways to man. (auth)

48194 THEORETICAL, EXPERIMENTAL, AND FIELD STUDIES CONCERNING DIFFUSION OF RADIOISOTOPES IN SEDIMENTS AND SUSPENDED PARTICLES OF THE SEA. PART B: METHODS AND EXPERIMENTS. Duursma, E. K.; Bosch, C. J. (International Lab. of Marine Radioactivity, Monaco). Radioact. Sea; No. 26, 77p(1970).

Reprinted from Neth. J. Sea Res.; 4: 395-469(1970).

Experiments were performed to verify the validity of previously developed mathematical models of radioisotope diffusion in sea sediments. Methods were developed for determining the diffusion coefficients and distribution coefficients of sorption. Physico-chemical interaction processes between sediments and a number of important isotopes were investigated. The mathematical models were experimentally verified and the following conclusions made:

under the conditions of the models, penetration into a sea sediment, due to concentration gradients, can be regarded as a diffusion process; the model for diffusion into a sediment from a thin supernatant current is applicable only if no sorption by the sediment occurs; and the results show that for diffusion of radionuclides in sea sediments the diffusion coefficients are between 10^{-11} and 10^{-6} cm^2/sec, depending on the sorption of the migrating radionuclides from the interstitial water by the sediment particles. (L.C.L.)

48195 URANIUM CONTENT AND THE ACTIVITY RATIO $^{234}U/^{238}U$ IN MARINE ORGANISMS AND SEA WATER IN THE WESTERN NORTH PACIFIC. Miyake, Yasuo (Tokyo Univ. of Education); Mayeda, Masaru; Sugimura, Yukio. Nippon Kaiyo Gakkaishi; 26: 123-9(Jun 1970).

The uranium content and activity ratio $A^{234}U/A^{238}U$ were determined in open ocean water, marine plankton, marine algae and seawater in the environment in which plankton and algae live. The average uranium content of $3.34 \pm 0.28 \times 10^{-6}$ g/l and the average activity ratio of 1.13 ± 0.04 were obtained in open ocean water. The uranium contents in plankton and algae were respectively from 1.7 to 7.8×10^{-7} g/g and 0.4 to 23.5×10^{-7} g/g on dry basis with the respective concentration factors of 48 to 260 and 10 to 733. The activity ratio in plankton and algae ranged from 1.07 to 1.18 which coincided well with those in the environmental seawater. (auth) (Japan)

48196 THORIUM CONCENTRATION AND THE ACTIVITY RATIOS $^{230}Th/^{232}Th$ AND $^{228}Th/^{232}Th$ IN SEA WATER IN THE WESTERN NORTH PACIFIC. Miyake, Yasuo (Tokyo Univ. of Education); Yasujima, Tadahide; Sugimura, Yukio. Nippon Kaiyo Gakkaishi; 26: 130-6(Jun 1970).

The concentration of thorium isotopes and the activity ratios of $^{230}Th/^{232}Th$ and $^{228}Th/^{232}Th$ in seawater collected in the Kuroshio region, the mixing area of Oyashio and Kuroshio, the Japan Sea and the East China Sea in the western North Pacific were determined. Thorium isotopes were analyzed by α-ray spectrometry after separating them with an anion exchange resin. The average content of thorium (^{232}Th) of 2.2×10^{-9} g/l was obtained in the open Pacific waters. The ratio of $^{230}Th/^{232}Th$ is in agreement with that of the top layer of the sediment in the same area. The high values of $^{228}Th/^{232}Th$ ratio up to 36 were observed in seawater. The excess ^{228}Th in seawater may be due to the migration of ^{228}Ra through the water-sediment interface. Thorium content in suspended matter was 10 to 20% of the total thorium content in the Pacific water. (auth) (Japan)

Seismology

48197 (ORNL-TM-3154) EARTHQUAKES INDUCED BY UNDERGROUND FLUID INJECTION. McClain, W. C. (Oak Ridge National Lab., Tenn.). Oct 1970. Contract W-7405-eng-26. 17p. Dep. CFSTI.

In 1966, an unusual series of earthquakes near Denver, Colorado, were correlated with deep well waste disposal operations at the Rocky Mountain Arsenal. Since that time, additional investigations have confirmed the postulated cause-and-effect relationship and have established the mechanisms responsible. Because of this experience, various questions have been raised about the possibility of a similar occurrence related to ORNL's hydraulic fracturing waste disposal practices. The mechanisms of the Denver earthquake sequence are examined in detail and the conditions necessary for such a phenomena determined. These conditions are so stringent that only in very rare occasions are they approached in normal industrial or oil field deep well disposal operations. By applying these necessary conditions to the situation existing at the Oak Ridge site, it can be unequivocally demonstrated that hydraulic fracturing operations cannot result in earthquakes by the mechanism responsible at Denver. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 48187 and 48544.

48198 (CEA-R-4036) UNDERGROUND NUCLEAR EXPLOSIONS. DAMAGE CAUSED TO NATURAL RELIEF FORMS. RESULTS FROM THE SAHARA TEST SITE. Faure, Jean (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Sep 1970. 27p. (In French). Dep. CFSTI (U. S. Sales Only).

Underground nuclear explosions cause localized earthquakes. The relief structure can be affected by these earthquakes. On the Sahara test site a refined observation technique made it possible to classify the various morphologies and the corresponding types of damage. A precise example is used to illustrate the application of this method for the analysis of damage caused on a test site of relief structures. Laws derived from these observations relate the amount of damage to the characteristic parameters of the seismic wave. The results may be of interest in the case of test sites safety and civil engineering work. (auth) (France)

48199 (NVO-294-4) PROJECT RULISON; ON-SITE RADIOLOGICAL SAFETY REPORT, APRIL 21-DECEMBER 31, 1969. (Eberline Instrument Corp., Santa Fe, N. Mex.). 17 Apr 1970. Contract AT(26-1)-294. 17p. (PNE-R-35). Dep. CFSTI.

The radiological safety support provided for Phase II of project RULISON, the second experiment in which a nuclear explosive was used to stimulate the production of natural gas, is described. This support included installation, calibration and operation of a remote area monitoring system, personnel dosimetry, environmental sampling, survey and monitoring activities and exclusion area control. All of the above activities indicated no release of radioactive materials to the environment. (auth)

48200 (ORNL-TM-3116) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, April 1-June 30, 1970. Arnold, W. D.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). 25 Aug 1970. 28p. Dep. CFSTI.

Projects described include studies of the behavior of radionuclides in the recovery of copper from nuclear broken ore deposits; studies of the behavior of radionuclides in the recovery of oil from nuclear broken oil shale; analysis of gas samples from nuclear-stimulated natural gas wells; and studies of the behavior of radionuclides in storage reservoirs created with nuclear explosives. (D.H.M.)

48201 (SC-RR-70-525) CRATERS FROM ROWS OF CHARGES DETONATED ONE AT A TIME IN PERMUTED SEQUENCES. Vortman, L. J. (Sandia Labs., Albuquerque, N. Mex.). Sep 1970. 38p. Dep. CFSTI.

While crater volume is about 50% greater when row charges are detonated simultaneously than when fired in ordered sequence, the latter method is more desirable from a seismic safety standpoint. It was suggested that permuted sequences might regain some of the lost volume. Rows of seven 64-pound charges were detonated one at a time in the orders 1-3-5-7-2-4-6 and 1-3-5-7-6-4-2. Resulting crater dimensions were not significantly different from those produced by sequential detonations. It is concluded that these two permutations, at least, give no advantage in regaining the lost crater volume. (auth)

48202 (UCRL-Trans-10475) RADIOACTIVITY IN CONTAINED UNDERGROUND NUCLEAR EXPLOSIONS. Izrael, Yu. A. Translation of Radioaktivnost' pri Kamufletnykh Podzemnykh Yadernykh Vzryvakh, USSR State Committee on the Uses of Atomic Energy, Moscow, 1970. 10p. (CONF-700305-4). Dep. CFSTI.

From Meeting on Technical Aspects of Peaceful Uses of Nuclear Explosives, Vienna, Austria.

The behavior of radioactive products in contained underground nuclear explosions is described. This is important for understanding the phenomenology of such explosions as well as for the safe conduct of explosions for peaceful purposes. A method is described for activating the melt and particles in the cavity, and graphs showing the time dependence of a number of different isotopes are given. The effective time in which the activation of the melt is completed under normal conditions is found by correlating the fractionating coefficients in underground explosions. The time is 40 seconds in the case of cratering explosions and longer in the case of contained ones. The role of induced activity in underground explosions is discussed, and it is suggested that the activation of the rock elements should be calculated in such cases for neutron energies of 10 to 100 eV (and not in thermal approximation). The possibility of gaseous radioactive products escaping into the atmosphere during a contained explosion is also considered. (auth)

48203 (UCRL-Trans-10476) METHODS OF MODELING EJECTION WITH CONSIDERATION OF THE FORCE OF GRAVITY. Rodionov, V. N. Translation of Metody Modelirovaniya Vybrosa s Uchetom Sily Tyazhesti, USSR State Committee on the Uses of Atomic Energy, Moscow, 1970. 13p. (CONF-700305-5). Dep. CFSTI.

From Meeting on Technical Aspects of Peaceful Uses of Nuclear Explosives, Vienna, Austria.

An experimental unit for studying the formation of a crater due to expansion of gaseous explosion products following the process of rock crushing by direct waves and waves reflected from the free surface is described. The initial parameters of the cratering process are the depth and dimensions of the cavity and the pressure of gases inside it. The model of crushed rock is dry sand. The relative magnitude of the force of gravity was varied by reducing atmospheric pressure. An empirical dependence has been established between crater dimensions and the energy of gas in the cavity, depth and other parameters. The results of the model experiments show a good agreement with those of large TNT and nuclear explosions. (auth)

Facilities and Equipment

Refer also to abstracts 48290, 48805, 48806, 49082, 50126, and 50193.

48204 (AERE-R-6496) INDUSTRIAL SCALE ION IMPLANTATION FACILITY. Freeman, J. H.; Caldecourt, L. R.; Done, K. C. W.; Francis, R. J. (Atomic Energy Research Establishment, Harwell (England)). Aug 1970. 9p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

A machine designed for ion implanation on an industrial scale is described. The facility consists of a small isotope separator capable of delivering milliampere intensity beams of a wide range of ions, and an automatically controlled high voltage target chamber. The throughput depends upon both the required uniformity and dose, but is typically about thirty two-inch diameter wafers per hour for a dose of 5×10^{15} ions/cm^2 and a doping uniformity of approximately $\pm 1\%$. The total combined energy of the separator and the target chamber is 200 keV, but a convenient maximum for routine operation is about 150 keV. For many dopants higher energies (>300 keV) can be obtained by using doubly or triply charged ion beams. The target chamber was designed to cover a wide range of both industrial and experimental implanation requirements. Precise beam alignment can be achieved over large sample areas and provision for target heating and cooling is included. (auth) (UK)

48205 (CONF-690954-, pp 2-21) OPERATION AND MODIFICATION OF THE DEEP FIELD MICROSCOPE. Kelly, M. D.; Selle, J. E. (Mound Lab., Miamisburg, Ohio).

From Technical papers of the 23rd metallographic group meeting held September 11-12, 1969, San Francisco, California.

The deep field microscope enables the microscopist to photograph specimens of varying size and unusual shape. Because of its great depth of field, this instrument's specimen range far exceeds that of other optical microscopes of equivalent magnification. It has a theoretical depth of field of 6 mm at 38× magnification and a depth of field of 600 μm at 250× magnification. Several problem areas and limitations to its use were encountered. The operation of the microscope, its limitations, and examples of its application and range of usefulness are discussed. The resolution of the microscope is a function of width of beam of light on the specimen and proper alignment of the light source. Alterations to the microscope were made to improve these characteristics and to improve the resolution. (auth)

48206 (DP-Report-370) SAFETY DOCUMENT FOR THE DRAGON FUEL ELEMENT DEVELOPMENT LABORATORY COMPLEX. Project DRAGON. Gough, J. R. C.; Harman, B.; Leyshon, T. T. (Atomic Energy Establishment, Winfrith (England)). Aug 1965. 122p. Dep. CFSTI (U. S. Sales Only).

The safety aspects of the fuel development and fabrication processes are examined. While the emphasis at present is on the preparation of fuel particles containing uranium and carbon, or

uranium, thorium and carbon, their coating with pyrolytic carbon and subsequent consolidation into a graphitic matrix, other requirements may arise. In this case any extension of the facilities or processes described will be the subject of a separate report, if it is considered that new or increased hazards are involved. (auth)

48207 (DP-Report-371) SAFETY ASSESSMENT FOR DRAGON FUEL ELEMENT PRODUCTION SECOND AND SUBSEQUENT CHARGES. Project DRAGON. Houdaille, M.; Price, M. S. T. (eds.) (Atomic Energy Establishment, Winfrith (England)). Aug 1965. 207p. Dep. CFSTI (U. S. Sales Only).

Safety evaluation for the production of the second and subsequent fuel charges for the Dragon reactor is presented. Included are safety regulations, descriptions of facilities and equipment, descriptions of fuel fabrication procedures, and procedures for fissile material control. (J.R.D.)

48208 (NP-18451) PRELIMINARY STUDY OF THE CHOPPER FOR COMPLETE FUEL ELEMENTS BUNDLES OF THE SNR-Na2 IN THE WAK. Roth, B. F.; Becker, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Dec 1969. 45p. (In German). Dep. CFSTI (U. S. Sales Only).

Literature and experimental tests show, there are no fundamental problems to solve in the fabrication of a chopper for complete fuel elements. In building a chopper for bigger fast breeder fuel elements for the sake of experience, it seems to be sensible to assemble and build a chopper with a prototype scissor for SNR Na2 fuel elements although the main arguments for a multiple chopper such as bigger output, is not yet valid. The output for a prototype chopper for closed fuel cycles of SNR Na2 system was calculated as an example. This output depends on the fuel reprocessing and refabrication capacity. (auth)

48209 (TID-4100(Suppl.59)) ENGINEERING MATERIALS LIST. Supplement 59. Smith, Richard J.; Sachs, Francis L.; Clark, Willie E. (eds.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Aug 1970. 52p. DTIE Free.

Twenty-three CAPE packages are described that contain information on reprocessing facilities, wind recorders, cable calibrators, controllers, carbon-13 production, calorimeters, FM measuring instruments, SO_2 meters, transducers, NOVA equipment, tubing transporters, microprobes, gamma detectors, diode oscillators, electrostatic analyzers, glass forming machines, pycnometers, and template holders. (J.R.D.)

48210 (TID-25511) SOME ENGINEERING PROBLEMS IN THE PRODUCTION OF STATIONARY MAGNETIC FIELDS. Luton, James Norfleet Jr. (Tennessee Univ., Knoxville). Jun 1970. 247p. Dep. CFSTI.

Aspects associated with production of steady magnetic fields by the use of room-temperature magnet coils without iron are investigated. Work on the theory, technology, design, construction, and evaluation of such coils is discussed. A field was produced having both a certain strength and homogeneity by means of a coil using minimum power. The appropriate axial variation of ampere turns was achieved by a design using "pancake coils" with various current densities. The field of the coil was calculated to be homogeneous to one part in 10^4 over a roughly spherical volume 8.3 in. in diameter, and its predicted field strength of 61.5 kC was 89% of the maximum field strength obtainable from a coil with rectangular cross section and uniform current density having the same bore (13 in.) and power (7 MW). The measured field strength was equal to the predicted value, but because of an asymmetry introduced during manufacture of the coil, the initially measured homogeneity was relatively poor. A great improvement in the field symmetry about the midplane has been achieved by mechanical shimming between pancakes and by using a novel system of trimming windings inside the hollow conductors of the coil. Calculations show that the addition in the bore of a pair of tilted elliptical loops of one turn each would improve the azimuthal asymmetry and give a field homogeneity very nearly equal to that of the original design. However, even with only the mechanical shimming, the asymmetry was not severe enough to change markedly the volume over which the field was uniform to one part in a thousand. The field measurements were made with a three-element Hall probe whose location in the coil bore was controlled and reported by a positioner designed to move the probe along cylindrical coordinates. The use of coils wound of grooved copper strip interleaved with an insulating strip is also reported. Self-fields of 45 kG were obtained with such "ribbon coils" immersed in a 50 kG external field, and it appears that this performance can be readily improved. Even with 80% of the coil volume devoted to the conductor and 13% used for insulation, with only the remaining 7% given to the coolant, the arrangement provides approximately 14 $in.^2$ of cooling surface per cubic inch of winding volume. Therefore, the coil temperatures were not excessive even with overall current densities of 200 $kA/in.^2$ Several items of importance to the technology of hollow-conductor coils were investigated and new solutions presented. These items include coil cooling, new versatile arrangements of the windings, prefabricated "crossovers," and crossover arrangements with compensation of undesired current components. (auth)

48211 EFFECT OF IODINE CONCENTRATION ON THE EFFICIENCY OF ACTIVATED CHARCOAL ADSORBERS. Craig, Douglas K.; Adrian, H. W. W.; Bouwer, D. J. J. C. (National Nuclear Research Centre, Pelindaba, South Africa). Health Phys.; 19: 223-33(Aug 1970).

Activated charcoal adsorbers are widely used in the nuclear energy industry to remove halogen vapors from gaseous effluents. Because efficiency tests conducted on several sets of adsorbers installed in the emergency ventilation system of the SAFARI-I reactor yielded unsatisfactory results, a rig for testing individual units was constructed. Using ^{131}I-labeled iodine vapor, several independent efficiency tests were conducted on sixteen different adsorber units. Only six of seventy-four results exceeded 99% and efficiency appeared to decrease sharply as upstream iodine concentration decreased. Therefore, intensive tests over an upstream iodine concentration range of 0.3 to 300 $\mu g\ I_2/m^3$ air were conducted on one unit only. Within the range of variables tested, only the concentration seemed to affect the decontamination factor. Further tests followed and attempts to detect methyl iodide either before or after the adsorber units by chemical analysis have so far failed. Tests generating methyl iodide in concentrations from 0.1 to 2000 $\mu g/m^3$ showed that the efficiency of both impregnated and unimpregnated adsorbers was independent of concentration. Tests conducted on twelve new KI impregnated adsorbers displayed the same concentration dependence as the non-iodized units. The implications of this important result are discussed in relation to adsorber testing and the iodine concentrations that are likely to arise following an accidental iodine release. (auth) (UK)

48212 500 KW ELECTRON BOMBARDMENT FURNACE FOR VACUUM METALLURGY. Guesne, P. (Alcatel-Heurtey, Paris). Tech. Mod.; 62: 219-21(May 1970). (In French).

The production of metallic alloy ingots with a length of two meters was made in the furnace. The diameter and the weight of these ingots depend upon the type of metal used. The casting of reactive alloys was performed by skull melting (e.g., titanium). The mode of operation and the structure of the 500 kW Alcatel-Heurtey furnace are then described: the electron gun and its electricity supplies, the melting mechanisms, the handling and the skull melting. (auth) (France)

48213 APPARATUS FOR PLUGGING HEAT EXCHANGER TUBES. Roznovsky, Walter (to Waagner-Biro Aktiengesellschaft). British Patent 1,207,790. 7 Oct 1970. Priority date 1 Jul 1968, Austria.

An apparatus is described which is capable of closing off defective interior tubes of heat exchangers in which the tubes are situated so that ready access cannot be had to the tube sheets from which the tubes extend. The apparatus is used to insert a plug having a closed end and deformable tubular wall portion extending from the closed end and expanded against the heat exchanger tube wall. (J.R.D.)

48214 DEVELOPMENT OF A GAS ANALYZER WITH MAGNETIC SECTOR. Vassenaix, M.; Gilles, J.; Swiners, B. (Thomson-CSF, Chatou, France). Vide; No. 146, 94-8(Mar-Apr 1970). (In French).

A small 180° deflection analyzer was developed for residual gas analysis in ultrahigh vacuum by mass spectrometry. Quantitative and qualitative measurements were carried out with such an apparatus. (auth) (France)

48215 APPARATUS FOR IRRADIATING ARTICLES. (to Saint-Gobain Techniques Novelles). British Patent 1,206,151. 23 Sep 1970. Priority date 9 Sep 1966, France.

An apparatus for uniformly exposing several articles simultaneously to radioactive sources is described. Two radiation sources in the form of cylinders are used. A sample holder is arranged so that the specimens are moved in circuits around the sources. (J.R.D.)

48216 EXPERIMENTAL DETERMINATION OF THE SIGN OF THE LOW ENERGY I = 0, 1 = 0$\pi\pi$ SCATTERING PHASE. Cline, D. (Univ. of Hawaii, Honolulu. Univ. of Wisconsin, Madison); Braun, K. J.; Scherer, V. R. Contract AT(11-1)-881. Nucl. Phys.; B18: 77-84(1970).

Using a sample of peripheral $\pi^+d \rightarrow p(p)\pi^0\pi^0$ events the cross section for this reaction was compared to the cross sections for

$\pi^- p \rightarrow \pi^+ \pi^- n$ and $\pi^+ p \rightarrow \pi^+ \pi^+ n$ at the mean momentum of 2.15 GeV/c. Using this comparison it is concluded that these reactions are dominated by OPE for masses down to near $\pi\pi$ threshold. Furthermore the mean value of the ratio $\langle \delta_0 / \delta_2 \rangle = -3.1 \pm 1.1$ was determined for low $\pi\pi$ mass. This relation is in good agreement with Weinberg's current algebra predictions. Assuming that δ_2 is negative in the ρ-mass region, it is shown that δ_0 is positive down to $\pi\pi$ masses very near threshold. Finally, the T = 0 and T = 2 scattering lengths are obtained using a forward-dispersion-relation sum rule. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 48213, 48827, and 50124.

48217 (RISO-207) CRITICAL LITERATURE STUDY ON SCALING LAWS FOR HEAT TRANSFER AND BURN-OUT IN TWO-PHASE FLOW WITH SPECIAL REFERENCE TO BOILING-WATER REACTORS. Andersen, Rolf; Pejtersen, Vagn S. (Danish Atomic Energy Commission, Risoe, Research Establishment). Aug 1969. 123p. Dep. CFSTI (U. S. Sales Only).

The use of correlation analysis and scaling laws for predicting burnout in two-phase flow is discussed on the basis of experimental results from various sources, with emphasis on experiments with water and Freon. It is concluded that these methods have so far met with only moderate success, and the use of azeotropes is proposed. It is shown that this may lead towards better understanding of scaling laws. A short survey of concepts such as similitude, dimension, dimensional analysis, fractional analysis of overall equations, and fractional analysis of governing equations and conditions is attempted. (auth)

48218 (ZJE-63) DIMENSIONLESS THERMAL STRESS IN A PLATE. Fojticek, C. (Skoda Concern, Pilsen (Czechoslovakia), Nuclear Power Plants Div.). 1969. 42p. (In German). Dep. CFSTI (U. S. Sales Only).

Equations for one dimensional heat transfer in an infinite plate, which is insulated from heat on one side and exposed to time-dependent exponential temperature changes on the other side, are derived in dimensionless form and used to express stress. The numerical solution is programmed in computer code ELLIOT. The relationships for dimensionless maximum thermal stress are calculated, tabulated, and presented graphically. An associated dimensionless critical time factor is also calculated and tabulated. (tr-auth)

48219 CAUSES OF DEPOSITS ON HEATED SURFACES COOLED BY ORGANIC COOLANTS. Bogdanov, F. F. Teploenergetika: No. 1, 64-8(Jan 1970). (In Russian).

Test results are given for the effects of temperature of the heated surface, polymer and iron oxide content, and coolant flow rate on the accumulation of particles deposited on heating surfaces cooled by organic coolants. It was found that high temperature or the presence of surface boiling on the heated surface wall and high polymer content in the coolant are the main causes for fast accumulation of deposits on the surface. However, neither the coolant flow rate nor corrosion influence this deposition significantly. (R.V.J.)

Isotope Technology

Refer also to abstracts 48215, 48253, 48260, 48349, and 48988.

48220 (BNWL-1308-3) PACIFIC NORTHWEST LABORATORY DIVISION OF ISOTOPE DEVELOPMENT PROGRAMS. Quarterly Report, May-July 1970. Hansen, J. E. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 47p. Dep. CFSTI.

Results are presented for the compatibility of Sm metal (stand-in for Pm metal) with containment materials. The materials showing the least interaction with Sm include Ta, Ta-10W, Ti, Zr, and TZM. Definition of a complete flowsheet for HWMP strontium purification is continuing. Measurement of the decay of ^{102m}Rh of the last 12 months indicates a half-life of 3.4 ± 0.8 years. Accomplishments on the NDT methods and device development program included the final construction and testing of the multielement transducer and cathode ray tube (CRT) readout systems, including a new contrast reversal readout technique. NDT technology initially developed on other BNW programs continued to be utilized when a pulsed laser schlieren system was used to image the ultrasonic beam pattern from the multielement system's transmitting transducer. DID headquarters and several contractors were visited for programmatic discussions to ensure that the program remains relevant to the needs of the contractors and industry. The evaluation of using rf-sputtering to prepare thin-film radiation sources was continued. Stainless steel, among other materials, appears to be good candidate material for alpha-radiation sources. Preparation of Nuclide Tables containing the properties of 2000 nuclides and isomers was completed. A comparison of ^{147}Pm and ^{238}Pu as circulatory support heat sources indicates that ^{238}Pu is the more advantageous source, primarily due to the ^{146}Pm impurity and the longer half-life of ^{238}Pu. A feasibility demonstration of the seabed mineral exploration technology was conducted at Battelle-Northwest's Marine Research Laboratory at Sequim, Washington. A 210 μg ^{252}Cf source was used. This demonstration verified expectations that many of the precious elements can be measured at concentrations of a few ounces per ton. (auth)

48221 (GA-8955) STATIC STRESS ANALYSIS FOR THE NAVSAT THERMOELECTRIC GENERATOR. Buttemer, D. R.; Hughes, P. T. (Gulf General Atomic, Inc., San Diego, Calif.). 9 Sep 1968. Contract AT(29-2)-2564. 35p. Dep. CFSTI.

Results of static structural analysis on the 30W NAVSAT thermoelectric generator, including both the generator frame and heat source support structure are presented. These results are the basis of the conclusion that the as-designed structure satisfies the stress criteria imposed by the combined 36 g axial acceleration and the 5 g lateral acceleration. However, an overstress condition results from superimposing an additional stress induced by an 0.08 psi internal pressure, which is produced within the generator structure during launch. Because of this consideration and dynamic response considerations, the beams on the end panel were redesigned and analyzed. The new configuration satisfies all the static load criteria. (auth)

48222 (GA-9515(Pt.2)) THERMOELECTRIC GENERATORS FOR SPACE MISSIONS. Annual Summary Report, July 1, 1968-June 30, 1969. Bradshaw, G. B.; Brislin, R. J.; Cruver, J. E. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Oct 1969. Contract AT(29-2)-2564. 175p. Dep. CFSTI.

Activities in programs directed toward development of lightweight, long-lived radioisotopic thermoelectric generators for general application in space missions are summarized. Information is included on design and testing of Isotec generators, Isotec systems studies, and generator fabrication. (J.R.D.)

48223 (GA-9515(Pt.2)(Suppl.A)) THERMOELECTRIC GENERATORS FOR SPACE MISSIONS. Annual Summary Report, July 1, 1968-June 30, 1969. Supplement A. Bradshaw, G. B. (Gulf General Atomic, Inc., San Diego, Calif.). 1 Apr 1970. Contract AT(29-2)-2564. 75p. Dep. CFSTI.

An exploratory degradation investigation of ISOTEC thermoelectric elements typical of those to be used in the TRANSIT RTG is described. Degradation mechanisms through the interpretation of element life-test data, element geometry changes, and through estimates of potential porosity buildup were found. Additionally, literature has been reviewed in an effort to relate observed changes to those reported by other investigators and for the purpose of estimating the relationship between thermal and electrical resistance changes. One of the major study objectives, besides elemental performance analysis, was to bracket the expected changes due to various degradation modes. For instance analysis indicated only 0.2 to 0.5% increase in n- and p-element resistance, respectively, due to sublimation effects after 5 years at 400°C. Results of porosity evaluation indicated that resistance will change nearly proportionally to the increase in porosity, and will rise only a few percent due to typical trends of porosity redistribution. Thermal conductivity was found to decrease almost directly with porosity buildup and was affected only slightly by porosity redistribution. The effect of microcracks was not considered, but is believed to be comparable to porosity except for very severe cracking conditions. Element degradation mechanisms are reviewed and recommendations for further study are included. (auth)

48224 (RPI-3816-4) STUDY OF IMPROVED ISOTOPE EXCITED LIGHT SOURCE TECHNIQUES. Final Report. Harteck, P.; Dondes, S. (Rensselaer Polytechnic Inst., Troy, N. Y.). Jan 1970. Contract AT(30-1)-3816. 18p. Dep. CFSTI.

Using polonium-210 alpha particles to irradiate helium-nitrogen gas mixtures (nitrogen concentrations 0.1 to 0.001%), an intense emission of the molecular nitrogen ion, (first negative system) was produced, the 0,1 line at 4278 Å in the violet being most intense to the eye. The strongest band, at 3914 Å i.e. ($v^1 = 0$, $v^{11} = 0$) was not in the visible range but provided the most intense emission as recorded by the 931 photomultiplier which has its maximum response at 4000 Å. Similarily, the polonium-210 alpha irradiation of pure neon gas produced an intense emission in the red. By using aluminum foil or coating the inner glass with a highly reflecting surface, the apparent brightness could be increased by a factor of 4 or 5 times that of a standard source using 1 curie of tritium (making

the necessary corrections for response of the photomultiplier to different wavelengths). Since these gas systems are inert, they are not consumed with time nor do they react with the radioisotope or the container and therefore the lifetime of the emission will simply depend upon the lifetime of the radioisotope. To date, the introduction of impurities due to the action of the alpha particles on the gas or the container were not observed. (auth)

48225 ISOTOPE TARGETS FOR NUCLEAR RESEARCH IN THE USSR. Com. Naz. Energ. Nucl., Notiz.; 16: No. 4, 73-4 (Apr 1970). (In Italian).

Considerations concerning the industrial use of isotope targets in research work in the USSR are given. Some types and methods of use are presented. (auth)

48226 PROTOTYPE MOCKUP CONVERTER (PMC-3) FOR SNAP-23A (6 May 1970) (Engineering Materials). (Minnesota Mining and Mfg. Co., St. Paul. Isotope Power Lab.). (CAPE-2022).

104 drawings.

The T/E converter produces electric energy in a usable form from heat supplied from the nuclear powered heat source designed for SNAP-23A. The PMC-3 is similar to the PMC-2 except that the PMC-1 cold frame is used to fit the hot frame to the system spud and to incorporate the Fe hot-junction electrodes. Indium foils reduce the temperature drop across the cold cap-follower interface from 48 to 30°F. Improved corrosion characteristics minimize T/E degradation. The cylindrical-converter is 10.6 in. long with a dia of 10.6 in., and a weight of 35 lbs. The nominal power output is 60W at 24V dc for 10 yrs. (For details see TID-4100 Suppl. 61) (F.S.)

48227 EXPERIMENTAL MOCKUP CONVERTER (EMC-3) FOR SNAP-23A (6 May 1970) (Engineering Materials). (Minnesota Mining and Mfg. Co., St. Paul. Isotope Power Lab.). (CAPE-2023).

102 drawings.

The EMC-3, like the PMC-3 described in CAPE-2022, produces electric energy in a usable form directly from heat supplied by a SNAP-23A isotopic source. The cylindrical converter is 10.6 in. in diameter, 8.2 in long and weighs 35 lbs. The nominal power output is 60W at 24V dc. The life span is 10 years. Bonded type P-legs are employed, indium foils at the cold cap-to-follower spherical interface reduce the temperature differential. (For details see TID-4100 Suppl. 61) (F.S.)

48228 OPTIMUM STEP COMPOSITIONS FOR STRIPPING AND ENRICHMENT SQUARED-OFF CASCADES. Oliveri, E. (Univ., Palermo, Italy). Energ. Nucl. (Milan); 17: 498-500 (Aug 1970).

The results are given of a calculation concerning the optimization of squared-off cascades for uranium enrichment. Such calculation is based on a method previously proposed by the same investigator. (auth)

48229 TIME OF FLIGHT OF IONS IN AN INHOMOGENEOUS OSCILLATORY ELECTRIC FIELD. Carrico, J. P.; Ferguson, L. D.; Mueller, R. K. (Bendix Research Labs., Southfield, Mich.). Appl. Phys. Lett.; 17: 146-8(15 Aug 1970).

The measurement of the time-of-flight of ions in an inhomogeneous oscillatory electric field is used to separate ions of different mass-to-charge ratios. Analytical and experimental results are reported. (auth)

48230 SNAP-21 THERMOELECTRIC POWER SYSTEM (30 Sep 1970) (Engineering Materials). (Minnesota Mining and Mfg. Co., St. Paul. Isotope Power Lab.). (CAPE-2024).

246 drawings.

The 10-W radioisotope powered thermoelectric (T/E) generator provides uninterrupted electrical power for underwater navigational aids, sonar beacons, seismological stations, and for general purpose oceanographic and ocean engineering applications to depths of 23,000 ft. The system which has a five-year design life, consists of the T/E generator, high-temperature vacuum insulation system, fuel capsule, biological shield, power conditioner, and pressure vessel. The generator is a 48-couple lead-tin-telluride/bismuth-antimony-telluride flat plate configuration. Fabrication techniques provide strong T/E element (leg) segment to segment bonds which result in minimum cross contamination. P-type leg hot junction contact resistance is reduced as is thermal impedance from the leg cold end to the cold frame. The high-temperature vacuum-insulation system supports the 265-lb biological shield while allowing minimum heat loss from the fuel. The vacuum system is hermetically sealed and incorporates chemical getters to maintain the hard vacuum for five years. The biological radiation shield is supported by a thin-walled neck tube at the generator end and three ball-joint tension-support rods at the other end. The power conditioner converts the output voltage of the generator from 4.8 to 24 V and regulates the voltage output by shunting excess power and acting as a load when no external load is attached to the system. The pressure vessel provides a watertight environment for five years at pressures up to 10,000 psi, serves as an attachment surface for external components, and provides an efficient and stable heat transfer path for heat rejection to seawater. The vessel is fabricated from Berylco 165 forgings that are heat treated to produce a yield strength of 130,000 psi. (For details see TID-4100 Suppl. 61) (F.S.)

48231 ADSORPTION OF RADIOISOTOPES ON THIN Al_2O_3-LAYERS PRODUCED BY ANODIC OXIDATION AS A METHOD FOR SOURCE PREPARATION. Thiele, R. W.; Cheng, W. P. M.; Yang, S. (National Tsing Hua Univ., Hsinchu, Taiwan). Nucl. Sci. J. (Taiwan); 7: 19-28(Oct 1969).

A new method for the preparation of alpha- and beta-sources by adsorption on thin aluminum oxide layers has been investigated. The aluminum oxide layer is obtained by anodic oxidation. Its thickness may be adapted to suit spectroscopic requirements by choosing appropriate experimental conditions. 30-66% adsorption of the nuclide under investigation is obtained within 60-90 minutes. Various parameters affecting the adsorption behavior have been investigated and sources of ^{241}Am, natural uranium, and ^{131}I were prepared by this method. (auth)

48232 OPTIMIZATION OF THE TAIL ENRICHMENT IN A DIFFUSION PLANT. Balakrishnan, M. R. (Bhabha Atomic Research Centre, Trombay, India). Energ. Nucl. (Milan); 17: 556-7(Sep 1970).

Equations for estimating separative cost in gaseous diffusion plants for UF_6 are developed. The separative work is assumed to consist of two terms, one independent of the separative work load and the other inversely proportional to the total annual separative work requirement. The charge is based on the operating expense per unit of separative work and the annual fixed charge. (J.R.D.)

48233 CALCULATION OF THE RELATIVE IRRADIATION DOSE RATE OF A HIGH-POWER GAMMA-SOURCE BY DIGITAL COMPUTER. Fejes, P.; Horvath, Zs.; Stenger, V. (Inst. of Isotopes, Budapest). Isotopenpraxis; 6: 98-103(Mar 1970).

A method is described which allows a digital computer to be applied for the calculation of the relative irradiation dose rates of the K-120,000 ^{60}Co gamma irradiation source with an activity of 80,000 Ci. The model used takes into consideration the joint effect of 80 source-elements which were one-dimensional but of different activities and arranged in four layers one above the other, around one/two imaginary cylinder superficies. In processing of chemical or physical dosimetry data this method can be applied also for the calculation of the absolute irradiation dose rates. According to the experiences obtained so far, over a distance of 6 cm-s from the source-elements the error of the computed absolute irradiation dose rate is less than 5%. (auth)

48234 RELATION BETWEEN ENERGY AND ERROR DUE TO NUCLEAR STATISTICS FOR DENSITY MEASUREMENT BY GAMMA RAY TRANSMISSION. Preiss, K. (Negev Inst. for Arid Zone Research, Beer-Sheva, Israel). Soil Sci.; 110: 151-6(Sep 1970).

Randomness of radiation emission from sources as a cause of error was investigated. It was shown that for a given thickness of soil measured, and for a given source strength, the time of observation required to obtain a given standard error of density depended on the source energy. The theoretical basis is described for choosing a source energy which gives the least error in density due to nuclear statistics or, by a definition which is identical and more practical gives the minimum time of count for a specified standard error in density due to nuclear statistics (called here, in short, time of count). Error due only to nuclear statistics, and to no other factors, is considered. An example problem is calculated, which shows that for greater soil thicknesses, a higher energy source gives a shorter time of count for a specified standard error, while for smaller thicknesses a lower energy source may give a shorter time of count. (J.R.D.)

Materials Testing

48235 GAMMA RAY INSPECTION OF HOT-MILL PRODUCTS. Kohn, A. (Institut de Recherces de la Siderurgie Francaise, Saint-Germain-En-Laye, France). Rev. Met. (Paris); No. 7-8, 609-17(Jul-Aug 1970). (In French).

The device was developed for the inspection of rolled long steel products. Therefore, the size and the position of the hole in the bloom head could be determined. The structure of the

commercial devices used by two French plants is described: container, detector, locking device, measuring bay, and control desk. The type of the defects that could be revealed with such an inspection device is studied. The results obtained on industrial scale operation are given. (auth) (France)

48236 NEUTRON RADIOGRAPHY. Alter, Henry Ward (to General Electric Co.). British Patent 1,206,655. 30 Sep 1970. Priority date 12 Dec 1966, United States.

A method and apparatus for track etching to produce neutron radiographs of objects are described. The apparatus has a source of neutrons, a sheet of detector material sensitive to charged particles, and conversion material for production of charged particles by reactions of neutrons not attenuated by the radiographed object. The ^{235}U conversion material produces alpha particles. The detector material is a polycarbonate resin. (J.R.D.)

48237 UNDERWATER GAMMA-RAY TESTING. Popov, S. Isotopenpraxis; 6: 31-3(Jan 1970). (In Russian).

A brief review is given of the application of γ-ray testing to inaccessible underground materials, e.g., materials used for underwater oil prospecting, and drilling equipment. Descriptions are given of the apparatus and its performance during tests for leakage of drilling installations at 12 to 15 m depth in the Black Sea. Corrosion and difficulty in protecting the source and testing apparatuses from water are discussed. (R.V.J.)

Radioactive Material Handling

Refer also to abstracts 48037 and 48197.

48238 (KFK-804) DEVELOPMENT OF SAFEGUARDS PROCEDURES FOR HEAVY WATER MODERATED, COOLED AND REFLECTED PRESSURISED WATER TYPE REACTORS. Schroeder, R.; Winter, H.; Gupta, D.; Haefele, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Apr 1970. 37p. Dep. CFSTI (U. S. Sales Only).

The final results of investigations on the development of safeguards procedures for heavy-water reactors similar to Atucha are described. After an analysis of the layout of the Atucha Reactor, the logical structure of the proposed safeguards measures was evolved. The basic measures are: confirmation of the final routes as given by the operator; sealing, identification, and checking the integrity of the fuel subassemblies; checking the movement of the subassembly moving mechanisms along the fuel routes; and monitoring the radiation level in the reactor bay area. Besides this, the inspection organization will receive information on integrated power generated, and shutdown history of the reactor at regular intervals. The instruments, accessories and actions required to implement these measures are discussed. A typical inspection visit to the Atucha reactor is described and an estimate of the efforts required for carrying out some development work is made. (auth)

48239 (KFK-1208) SOME INVESTIGATIONS ON NON-DESTRUCTIVE SAFEGUARDS TECHNIQUES. Baumung, K.; Boehnel, K.; Klunker, J.; Kuechle, M.; Wolff, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jun 1970. 21p. (SM-133/90; CONF-700701-4). Dep. CFSTI (U. S. Sales Only).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany.

Non-destructive assay techniques are studied at Karlsruhe with the purpose of identifying the optimal method or combination of methods for a practical safeguards system. The methods investigated experimentally included: slowing down time spectrometer; reactivity measurements; delayed neutron measurements; active and passive high resolution γ-spectroscopy; and coincidence measurements of spontaneous fission neutrons. The slowing time spectrometer was employed to measure the fission rate of fuel pins as a function of neutron energy in the range between 10 eV and 3,000 eV. When calibrated against a standard, this indicates the amount of fissile material. Discrimination between ^{239}Pu and ^{235}U is possible if counting rate ratios of appropriate energy ranges are taken. Accuracy and reproducibility of the method were checked. Reactivity measurements can be made with good accuracy in a short time but are normally no tamperproof determinations of the fuel content. However, if three measurements are made for each pin in sufficiently different environments, all important methods of cheating the determination can be excluded. An exception is constituted by radial inhomogeneities. This was demonstrated in an experiment made with an H_2O-moderated critical facility. The detection of fissile material in a simulated scrap barrel was studied with a pulsed source and the delayed neutron technique. The sensitivity of the result with respect to the location of the fissile material in the barrel and the density of the filling material (iron and paraffin) was investigated. Moderated and unmoderated targets were used. The 414 keV γ-line of ^{239}Pu can be used for accurate passive plutonium determination in fuel pins, provided that the homogeneous distribution of fuel is checked separately. This may be done by comparing the intensities of the γ- and X-rays emitted. The total fissile material content can be found by fission product γ-counting after short-term irradiation. This and some similar problems were studied by means of a Li-drifted germanium detector. A high sensitivity neutron counter was built to measure spontaneous fission of plutonium quickly and with high precision. A Rossi-α coincidence technique was used to discriminate against (α,n)-processes with a deadtime-free instrument. (auth)

48240 (RFP-1553) GENERALIZED AREA OF INTERSECTION MODEL FOR URANYL NITRATE FILLED PIPE INTERSECTIONS. Dickinson, Deanne; Schuske, C. L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 4 Sep 1970. Contract AT(29-1)-1106. 15p. Dep. CFSTI.

An empirical model is presented for calculating safe nuclear criticality parameters for complex arrays of intersecting pipes containing enriched uranyl nitrate solution. The current model, an extension of one presented in a previous report, is derived from Monte Carlo calculations as well as from experimental data. (auth)

48241 (TID-25515) QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM MATERIALS SPECIFICATIONS. REPORT I. BASIC PROGRAM. Tingey, F. H.; Balkovetz, F. J.; Lund, D. M.; Rein, J. E.; Spraktes, F. W.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). May 1968. Contract AT(10-1)-1230. 22p. Dep. CFSTI.

A program directed toward the qualification of U. S. commercial and foreign government laboratories to serve as umpires in AEC transactions involving uranium and plutonium materials is described. Qualification is based on a demonstrated ability to analyze the various materials for the various specification categories. The basic program is described. Reports will be issued which recommend the qualification of participating laboratories for each of the various materials. (auth)

48242 (TID-25516) QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM MATERIALS SPECIFICATIONS. REPORT II. FIRST REPORT ON URANYL NITRATE. Tingey, F. H.; Balkovetz, F. J.; Lund, D. M.; Rein, J. E.; Spraktes, F. W.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). [nd]. Contract AT(10-1)-1230. 79p. Dep. CFSTI.

A program directed to the qualification of U. S. commercial and foreign government laboratories to serve as umpires in AEC transactions involving uranium and plutonium materials is described. Qualification is based on a demonstrated ability to analyze the various materials for the various specification categories. The specifications, preparation and standardization of the uranyl nitrate standards are listed and described. The statistical analyses and qualification recommendations are presented for those participating laboratories that have completed the analysis of this material at this time. (auth)

48243 (TID-25517) QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM MATERIALS SPECIFICATIONS. REPORT III. FIRST REPORT ON URANIUM HEXAFLUORIDE. Tingey, F. H.; Balkovetz, F. J.; Lund, D. M.; Rein, J. E.; Spraktes, F. W.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). [nd]. Contract AT(10-1)-1230. 96p. Dep. CFSTI.

A program directed to the qualification of U. S. commercial and foreign government laboratories to serve as umpires in AEC transactions involving uranium and plutonium materials is described. Qualification is based on a demonstrated ability to analyze the various materials for the various specification categories. The specifications, preparation, and standardization of the uranium hexafluoride standards are listed and described. The statistical analyses and qualification recommendations are presented for those participating laboratories that have completed the analysis of this material at this time. (auth)

48244 (TID-25518) QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM MATERIALS SPECIFICATIONS. REPORT IV. FIRST REPORT ON PLUTONIUM NITRATE. Tingey, F. H.; Balkovetz, F. J.; Lund, D. M.; Rein, J. E.; Spraktes, F. W.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). Apr 1969. Contract AT(10-1)-1230. 41p. Dep. CFSTI.

A program directed to the qualification of U. S. commercial

and foreign government laboratories to serve as umpires in AEC transactions involving uranium and plutonium materials is described. Qualification is based on a demonstrated ability to analyze the various materials for the various specifications. The specifications, preparation, and analysis of the plutonium nitrate material by the AEC laboratories are listed and described. The statistical analyses and qualification recommendations are presented for those participating laboratories that have completed the analysis of this material at this time. (auth)

48245 (TID-25519) QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM MATERIALS SPECIFICATIONS. REPORT V. FIRST REPORT ON PLUTONIUM OXIDE. Tingey, F. H.; Balkovetz, F. J.; Lund, D. M.; Rein, J. E.; Spraktes, F. W.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). Jun 1969. Contract AT(10-1)-1230. 100p. Dep. CFSTI.

A program directed to the qualification of U. S. commercial and foreign laboratories to serve as umpires in AEC transactions involving uranium and plutonium materials is described. Qualification is based on a demonstrated ability to analyze the various materials for the various specifications. The specifications, preparation, and analysis of the plutonium oxide material by the AEC laboratories are listed and described. The statistical evaluations and qualification recommendations are presented for those participating laboratories that have completed the analysis of plutonium oxide at this time. (auth)

48246 (TID-25520) QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM MATERIALS SPECIFICATIONS. REPORT VI. FIRST REPORT ON PLUTONIUM METAL. Tingey, F. H.; Balkovetz, F. J.; Lund, D. M.; Rein, J. E.; Spraktes, F. W.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). Sep 1969. Contract AT(10-1)-1230. 104p. Dep. CFSTI.

A program directed to the qualification of U. S. commercial and foreign laboratories to serve as umpires in AEC transactions involving uranium and plutonium materials is described. Qualification is based on a demonstrated ability to analyze the various materials for the various specifications. The specifications, preparation, and analysis of the plutonium metal test material by the AEC laboratories are listed and described. The statistical evaluations and qualification recommendations are presented for those participating laboratories that have completed the analysis of plutonium metal at this time. (auth)

48247 (TID-25521) QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM MATERIALS. REPORT VII. FIRST REPORT ON ^{233}U ENRICHED URANYL NITRATE. Tingey, F. H.; Balkovetz, F. J.; Lund, D. M.; Rein, J. E.; Spraktes, F. W.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). Nov 1969. Contract AT(10-1)-1230. 17p. Dep. CFSTI.

A program directed to the qualification of U. S. commercial and foreign laboratories to serve as umpires in AEC transactions involving uranium and plutonium materials is described. Qualification is based on a demonstrated ability to analyze the different materials for the various specification categories. The specifications of ^{233}U enriched uranyl nitrate are listed and the preparation and analysis of a ^{233}U enriched uranyl nitrate test material by the AEC laboratories is described. Statistical evaluations and qualification recommendations are presented for those participating laboratories that have completed the analysis of ^{233}U enriched uranyl nitrate at this time. (auth)

48248 (TID-25522) QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM MATERIALS. REPORT VIII. FIRST REPORT ON URANIUM OXIDE. Tingey, F. H.; Balkovetz, F. J.; Lund, D. M.; Musgrave, B. C.; Spraktes, F. W.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). May 1970. Contract AT(10-1)-1230. 77p. Dep. CFSTI.

A program directed to the qualification of U. S. commercial and foreign laboratories to serve as umpires in AEC transactions involving uranium and plutonium materials is described. Qualification is based on a demonstrated ability to analyze the different test materials for the various components listed in the specifications. The specifications for uranium oxide are listed and the preparation and analysis of the uranium oxide test materials by the AEC laboratories are described. Because the specifications for the three uranium oxides (UO_2, UO_3, and U_3O_8) are identical, only U_3O_8 is being used as a test material. Statistical evaluations and qualification recommendations are presented for those participating laboratories that have completed the analysis of uranium oxide at this time. (auth)

48249 (TID-25524) QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM MATERIALS. REPORT X. SECOND REPORT ON URANIUM HEXAFLUORIDE. Tingey, F. H.; Balkovetz, F. J.; Lund, D. M.; Musgrave, B. C.; Spraktes, F. W.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 9p. Dep. CFSTI.

Results of precision tests on uranium concentration data from participating laboratories are presented. (D.H.M.)

48250 RADIOACTIVE WASTE DISPOSAL BY HYDRAULIC FRACTURING. de Laguna, Wallace. Nucl. Safety; 11: 391-400(Sep-Oct 1970).

The petroleum industry has developed, largely since World War II, the technique of hydraulic fracturing to increase oil recovery that is today almost universally used in reservoir rocks of low permeability. Single injections of 100,000 gal of oil containing 250,000 lb of sand are not unusual. Much the same equipment and procedure may be used for waste disposal, although there are certain significant differences. The disposal well at Oak Ridge was drilled and cased to a depth of 1000 ft in shale by using standard oil-field methods. The casing is slotted near the bottom, and for waste disposal a self-hardening mixture of waste, Portland cement, and clay is pumped down under high pressure to form a widespread, thin, horizontal fracture in the shale in which the waste sets up solid. After four injections into the same slot, totaling roughly 500,000 gal, the bottom of the well is plugged and a new slot cut some 10 ft higher up the well. Problems that had to be solved at Oak Ridge to make possible the operational disposal of medium-level radioactive waste were determining the geometry of the fractures formed in the shale, establishing the formula for a satisfactory waste–cement–clay mix, designing and constructing the surface plant, and formulating methods of monitoring the operation. (auth)

48251 SAFETY EVALUATION OF SOLIDIFIED RADIOACTIVE WASTES INTO THE GROUND. Inoue, Yoriteru; Morisawa, Shinsuke (Kyoto Univ.). Hoken Butsuri; 5: No. 2, 75-80(Jun 1970). (In Japanese).

The safety of ultimate disposal of solidified radioactive wastes into the ground was evaluated. It was assumed that ten percent of radionuclides contained in the waste was eluted into the ground by accident. Migration rates of radionuclides in the ground, the dispersion of nuclides in the sea, concentration of nuclides in the seafood, and radiation dose to the human environment due to disposal of radioactive wastes into the ground were estimated. The evaluation has shown that, under assumed conditions, this method of disposal was safe and promising. (auth) (Japan)

48252 WINCHES USED FOR THE HANDLING OF NUCLEAR MATERIALS. Martin, Jean (Groupement Atomique Alsacienne Atlantique, Le Plessis-Robinson, France). Ind. At.; 14: 47-52(1970).

The movement of materials in nuclear reactors with vertical channels particularly when in operation, poses new problems; the items transported include particularly the fuel elements, which are fragile, dangerous and not directly accessible. The winches used for the operation must be reliable, adaptable and suitable for remote control operation. The winches involve cable winding gear and tension measuring devices which make it possible to maintain the correct working cycle. The driving gear requires a special moving chain. These modifications ensure the satisfactory operation of the most delicate manipulations. (auth) (France)

48253 IMPROVEMENTS IN OR RELATING TO CONTAINERS FOR RADIOACTIVE MATERIALS. Lecuyer, Daniel. British Patent 1,206,767. 30 Sep 1970. Priority date 20 Dec 1966, France.

A container for a radioactive source is described. The container is designed to automatically expose the source using a controlled opening. An alarm is included to indicate incorrect positioning or size of the returned source. (J.R.D.)

48254 DESIGN OF STORAGE TANKS FOR LIQUID RADIOACTIVE WASTES. Zaborov, N. B. Sb. Tr., Mosk. Inzh.-Stroitel. Inst.; 56: 134-46(1968). (In Russian).

The total volume of liquid waste from 200 tons of nuclear fuel will be 400,000 to 4,000,000 m^3. Present capital costs run 100 to 530 dollars per cubic meter of capacity. The cost decreases with increasing storage capacity. Usually the acid wastes are neutralized with caustic. Various tank design and tank arrangements for storing liquid radioactive wastes are presented. A central pipe tunnel connecting with the various storage tanks is an essential design feature. Construction details of the tanks are discussed. (TTT)

Vacuum Engineering

Refer also to abstracts 48214 and 48348.

48255 ALUMINUM SORPTION ROUGHING PUMP FOR SMALL VACUUM SYSTEMS. Danielson, P. M. (Argonne National Lab., Ill.). J. Vac. Sci. Technol.; 7: 527-30(Sep-Oct 1970).

Sputter-ion pumped vacuum systems are commonly roughed with sorption pumps. The design and performance of a new pump that is tailored for use with small systems is described. The new pump is designed to maximize heat transfer between the liquid-nitrogen coolant and the Molecular Sieve by means of an aluminum pump housing and by providing internal aluminum rods welded to the bottom of the housing. The performance of the new pump was assessed by three series of tests on a small (4.65-liter) vacuum system. These tests showed that the pump performs satisfactorily without internal gas access screens or prechilling, and that it can repeatedly (>20 times) evacuate the test system without loss of maximum (1×10^{-6} torr in 7.5 min and 1×10^{-3} torr in 40 min) performance. (auth)

48256 STUDY OF HOT CATHODE MAGNETRON GAUGES. Iapteff, B.; Choumoff, P. S. (Societe Generale du Vide, Paris). Vide; No 146, 103-8(Mar-Apr 1970). (In French).

The principle of hot cathode magnetron ionization gages and some of their limitations are described and a new gage was studied which would allow measurements of pressures of about 10^{-12} torr. In order to increase its sensitivity, an axial wire collector put inside the anode was adapted, the filament being located near the other end of the anode volume. The residual current of about 2×10^{-13} torr is mainly due to the nature and the temperature of the filament. A sensitivity of about 0.2 A/torr was obtained. By direct comparison with other types of gages, it was possible to deduce the linearity of this magnetron gage between 10^{-12} and 10^{-8} torr. (auth) (France)

48257 ABSOLUTE CALIBRATION OF GAUGES IN ULTRA-HIGH VACUUM WITH AN ADJUSTABLE CONDUCTANCE. Bernardet, H. (Societe Generale du Vide, Paris); Choumoff, P. S.; Mativet, J.; Sauneuf, R. Vide; No. 146, 84-90(Mar-Apr 1970). (In French).

The usefulness of an adjustable conductance for the absolute calibration of gages in ultrahigh vacuums was made possible with an entirely bakeable mechanism put on the spherical calibration dome (75 cm diameter). The differential interferometric manometer, allowing direct measurements of conductance in a molecular flow, avoided difficult theoretical calculations. Extension of this method to lower pressures in the 10^{-9} torr range was only limited by the limit pressure obtained with the pumping device used. To measure the small amount of throughput needed, (about 1×10^{-7} torr l/sec), a constant volume flowmeter was built, where the admission pressure was also measured by means of a differential interferometric manometer. The relative accuracy in the analytical determination of the slope of the calibration lines was about 0.4% in the case of the first calibration of B.A. gages; at pressures of about 10^{-8} torr the sensitivity was thus directly determined with an accuracy of 5%. (auth) (France)

48258 APPLICATION OF LOW TEMPERATURES AND LOW PRESSURES IN SPACE. RESEARCH. Haefer, R. A. (Sulzer Bros., Ltd., Winterthur, Switzerland). Vide; No. 146, 65-83 (Mar-Apr 1970). (In French).

The problems of simulating the low temperature and vacuum conditions in space are discussed. Two different combinations were studied: the combination of 20°K cryogenic pumps with titanium sublimation pumps and ion pumps, and the combination of 20°K cryopumps with titanium sublimation pumps and turbomolecular pumps. These new pumping methods led to ultrahigh vacuums ($p < 10^{-11}$ torr) within large enclosures and have primary importance not only in respect to space research but in plasma physics, solid state physics and high energy particle physics. (auth) (France)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 48177.

General Detectors and Monitors

Refer also to abstracts 48627, 49646, and 50253.

48259 (BARC-498) EXPERIMENTAL RE-EVALUATION OF TWO-CRYSTAL SCANNING GEOMETRY FOR WHOLE-BODY COUNTING WITH LOG-SHAPE PLACEMENT OF CRYSTALS. Hukkoo, R. K.; Sharma, R. C. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 11p. Dep. CFSTI (U. S. Sales Only).

Two-crystal scanning geometry for whole body counting is experimentally re-evaluated with the log-shape placement of a squat cylindrical crystal detector. Data on the response of this geometry for various modes of movement of a ^{137}Cs point source inside a phantom are presented. It is found that the present geometry yields smaller deviation in the counting efficiency as compared to the values cited by Chhabra for Naversten's geometry. It is concluded that the use of variable scan speed recommended to improve the response of two-crystal scanning geometry using squat cylindrical crystals with vertical axis may be dispensed with when the suggested placement of detectors is chosen. (auth)

48260 (BMBW-FBK-70-8-B) EXPERIMENTAL PROBLEMS OF BACKSCATTERING FACTOR DETERMINATION OF β PARTICLES USING THE $2\pi-4\pi$ METHOD. Tautenhahn, F.; Puetz, W.; von Erichsen, L. (Bonn Univ. (West Germany). Institut fuer Physikalische Chemie). Jul 1970. 22p. (In German). Dep. CFSTI (U. S. Sales Only).

The production and gold layering in vacuo of extremely thin films for use as carrier foils in 4π-counting are described, and several methods for the determination of the thickness of film and gold layer, respectively, are pointed out. The sources of error leading to a falsification of the true 4π-disintegration rate are discussed. (auth)

48261 (CEA-CONF-1578) SPARK CHAMBERS AND THEIR APPLICATIONS TO NUCLEAR MEDICINE. Lansiart, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 19p. (In French). (CONF-700536-1). Dep. CFSTI (U. S. Sales Only).

From 12th Meeting on Exploration Techniques Using Radioactive Isotopes, Strasbourg, France.

The development of spark chambers is briefly reviewed, and their classification (operation by wall effects, gas particle interactions, three electrode chamber) and different recording techniques are discussed. An example is given of the excellent results obtained using the Kellershohm-Lansiart chamber for thyroid examination. (auth) (France)

48262 (EURFNR-805) ABSOLUTE NEUTRON FLUX DETERMINATION. Kappeler, F.; Frohner, F. H. (Kernforchungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Jun 1970. 9p. (KFK-1226; CN-26/9; CONF-700605-9). Dep. CFSTI (U. S. Sales Only).

From 2nd International Conference on Nuclear Data for Reactors, Helsinki, Finland.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

A proton recoil counter with a solid radiator and a solid state detector for absolute measurements of neutron beam fluxes above ~250 keV is described. The geometry is such that only protons emerging within a narrow cone around the forward direction are detected. Thus only relatively high-energy protons reach the detector and background correction is facilitated. A specially developed Monte Carlo program is used to normalize the spectra. The counter is fast enough (~18 nsec time resolution) for many time of flight applications. (auth)

48263 (LA-4254-TR) DETECTION AND MEASUREMENT OF RADIOACTIVITY IN VIVO IN THE HUMAN BODY. de los Santos Salinas, Francisco. Translated for Los Alamos Scientific Lab., N. Mex., from Energ. Nucl. (Madrid); 12: 573-91 (1968). 16p. Dep. CFSTI.

The application of radioactive isotopes to medicine and industry has created a risk of exposure to many types of ionizing radiation. A person may become internally contaminated with these isotopes through inhalation, ingestion, or absorption through the skin. Instrumentation has been developed which is capable of detecting and measuring these materials in vivo. This paper describes the performance characteristics of various types of detectors used for this purpose. The whole-body counting facility of the Spanish Nuclear Energy Council is described. (auth)

48264 (RLO-1925-42) DEADTIME CORRECTION FOR PULSED BEAMS. Battleson, K.; McDaniels, D. K. (Oregon Univ., Eugene. Dept. of Physics). [1969]. 9p. Dep. CFSTI.

A method is presented for making deadtime corrections for nonparalyzable electronic devices for the case of counting events from a pulsed beam of finite time spread and a counting interval which encompasses only a fraction of the interval between pulses. (auth)

48265 (ZJE-64) OPTIMUM TREATMENT OF POISSON'S PULSE TRAIN USING SEQUENTIAL ANALYSIS. Drab, F. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). Dec 1969. 30p. Dep. CFSTI (U. S. Sales Only).

The method considers the measurement of a parameter of a Poisson's pulse train as a problem of the statistical decision, i.e. as hypothesis testing which leads to the measurement optimization from the point of view of time and accuracy. This method is compared to the existing measurement methods and a number of possible applications are discussed. Some numeric relations for the symmetrical binary testing are developed. (auth)

48266 BASIC CONCEPTS OF A RECTILINEAR SCANNER. Cherico, Vincent V. (Cardinal Cushing General Hospital, Brockton, Mass.). Radiol. Technol.; 42: 91-3(Sep 1970).

This article is designed to introduce to the reader with limited electronic knowledge some concepts of rectilinear scanners, as well as some of the major components necessary to complete a rectilinear scan image. (auth)

48267 SCANNERS AND CAMERAS IN NUCLEAR MEDICINE. Voorhis, Mary W. Radiol. Technol.; 42: 72-5(Sep 1970).

There are two basic scanning devices used in nuclear medicine today—the rectilinear scanner and the scintillation camera. A comparison of the two is presented concerning the three basic essentials of scanning: the radioactive source, the radiation sensitive detector, and the readout. (auth)

48268 METHOD FOR CHARGED-PARTICLE DISCRIMINATION IN NUCLEAR EMULSION. Haseganu, D.; Nicolae, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 225-31(1970).

A method of discrimination for charged particles with different ionization powers is reported. It concerns the utilization of the solvatant amidol developer (containing NaSCN) as a discriminating developer. The high discriminating power of this method is proved by the results obtained in a few kinds of discrimination: fission-fission-α, α-p, heavy ions. This method allows the recording of the two fission fragments of uranium as individual tracks, without any α-particle background. A quantitative study of the developer activity variation, as a function of the NaSCN and amidol concentrations, is performed. (auth)

48269 MONITORING DEVICE FOR INDICATING A GIVEN RANGE OF INCIDENT RADIATION. Erikson, Herman E. (to Polaroid Corp.). U. S. Patent 3,519,820. 7 Jul 1970. Filed 13 Aug 1965.

The present application relates to a compact, relatively-simple and hence inexpensive device for indicating possibly injurious levels of incident radiation, e.g., X-ray and gamma radiation, within specified ranges. In its basic form, the device consists merely of a small housing element opaque to visible light but pervious to X-rays and gamma rays, an activatable component such as a given fluorescent substance or phosphor carried by and substantially coextensive with support means therefor of given area having a given range of light output and responsive to a given range of incident radiation, and components of an electrical circuit comprising a source of a given DC voltage such as a miniature battery, a photoresistor component physically superimposed with the aforesaid activatable component, and an indicating component such as an ammeter for providing a given range of current readings calibrated in terms relating to the radiation to be measured. In modified form, the device includes means for augmenting the range of incident radiation to which the device is sensitive. The indicating component may be enclosed in the housing or remotely situated, as provided by external connector means. (auth)

48270 PULSE SHAPE DISCRIMINATION IN STILBENE AND NE 213 SCINTILLATORS. Fujiwara, Y.; Yuasa, K. (Konan Univ., Kobe, Japan). Mem. Konan Univ., Sci. Ser.; No. 12, 101-9(Nov 1969).

The pulse shape discrimination circuit according to the charge comparison method has been built, and the identification efficiency of the circuit has been measured between neutrons and gamma-rays with both stilbene and NE 213 liquid scintillator. (auth) (Japan)

48271 PORTABLE RADIATION-EXPOSURE ALARM AND METER. Kasai, Tatsuo; Hayashi, Osamu; Iwatsuki, Tsunenobu (Fujitsu Ltd., Japan). FAPIG (Tokyo); No. 52, 253-5(Feb 1969). (In Japanese).

The constant monitoring of radiation, to which the personnel working under the high level of radiation is exposed, is necessary in an atomic power station. When the specified value of exposure is exceeded, an alarm must be sounded, and also some indication must be given as exposure approaches the set value. For this purpose, a portable alarm-meter has been developed by Fujitsu Limited, in association with Japan Atomic Power Company. The alarm-and-meter essentially consists of an alarm-meter proper, carried by a person, and a charge-reader. The alarm-meter is of an ionization-chamber with air as filling gas; and the charge reader with a battery is set on the ground, and is used to give a specific alarm level and also to read the dose of exposure. In the design and construction of the portable alarm-and-meter, the following matters were taken into consideration: (1) reduction in size and weight, actually, 115 mm × 68 mm × 25 mm and 230 grams for the alarm-meter proper; (2) anti-vibration structure, with no movable parts in the circuit; and (3) an electrical terminal to check the constancy in the operation of the alarm-meter proper. (Japan)

48272 EFFECT OF SURROUNDING GASES ON THE CHARACTERISTICS OF A MULTIPLE-WIRE-CAVITY SPARK COUNTER. Maeda, Keisuke (Konan Univ., Kobe, Japan). Mem. Konan Univ., Sci. Ser.; No. 12, 33-40(Nov 1969).

The effect of modification of the composition of surrounding air on the operating characteristics of a multiple-wire spark counter with a concave cathode for detection of α-particles was investigated experimentally as the continuation of the work for the counter with a plane cathode. It was confirmed that water vapor is important for stabilizing the operating characteristics, and is somewhat useful for obtaining high efficiency. To get high detecting efficiency, addition of ~20 mm Hg of carbon dioxide to ordinary air is very advantageous. Variation of the ratio of the partial pressures of oxygen and nitrogen shows rather complicated effects, giving the highest efficiency at about 5 mm Hg of oxygen. (auth) (Japan)

48273 IONIZING RADIATION SENSITIVE PHOTOGRAPHIC ELEMENT COMPRISING FOAMED GELATIN-SILVER HALIDE EMULSION. Audran, Roger G. L.; Delest, Philippe F.; Vige, Maurice (to Eastman Kodak Co.). U. S. Patent 3,516,834. 23 Jun 1970. Filed 18 Mar 1966.

New photosensitive, silver halide elements having a cellular structure and processes for making said elements are described. In one aspect of this invention, the cellular structure is a gelatin foam which has preferably been hardened. (auth)

48274 POSITION-SENSITIVE RADIATION DETECTOR. Borkowski, Casimer J.; Kopp, Manfred K. (to U. S. Atomic Energy Commission). United States Patent 3,517,194. 23 Jun 1970. Filed 24 Oct 1968.

An improved position-sensitive detector is provided by placing a timing reference electrode in the detector element together with a high resistance collector electrode. The high resistance collector electrode provides a pulse whose rise time is indicative of the impact position of a radiation event along the collector. The addition of the time reference electrode provides a reference pulse having a constant rise time independent of the impact position. Thus, by time comparison of the position independent reference pulse with the position dependent pulse the radiation impact position is determined with greatly increased spatial resolution and improved linearity. (auth)

48275 ELECTRONICS CIRCUITS ASSOCIATED TO MULTIWIRE PROPORTIONAL CHAMBERS. Pages, R. (SAIP, Malakoff, France). Nucl. Instrum. Methods; 85: 211-13(1970).

This paper describes an acquisition system for information delivered by multiwire proportional chambers allowing one to operate with chambers involving thousands of wires as with several chambers or detectors. (auth)

48276 InSb JUNCTIONS AS NUCLEAR PARTICLE DETECTORS AT LIQUID NITROGEN TEMPERATURE. Roth, S. (Siemens AG, Erlangen, Ger.). Nucl. Instrum. Methods; 85: 157-62 (1970).

InSb pn-junctions are used as semiconductor nuclear particle detectors at 78 K. From the response to alpha particles and protons the effective pair creation energy is found to be 2.4 eV. On the basis of these measurements and theoretical considerations, the probable advantages of InSb diodes over conventional detectors are discussed. It turns out that it is possible to count nuclear particles with InSb diodes, but none of the expected advantages can be realized at liquid nitrogen temperature. (auth)

48277 COOLING AND WARMING SYSTEM FOR Si(Li) CHARGED-PARTICLE DETECTORS. Stupin, D. M. (Univ. of Colorado, Boulder). Nucl. Instrum. Methods; 85: 325-8(1970).

A cooling and warming system for Si(Li) detectors in a scattering chamber is described. This system will cool a detector to −60°C or warm it to room temperature within five minutes (auth)

48278 STUDY OF SELF-POWERED DETECTORS FOR MIXED NEUTRON-GAMMA RADIATION FIELDS. Ramirez, G.; David, L. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Nucl. Instrum. Methods; 85: 279-83(1970).

The properties and behavior of the several types of self-powered detectors in a mixed neutron-gamma field are studied. A set of the various elements was used as electron emitters in order to obtain the best suitable electrode couples for neutron detectors with a very low gamma sensitivity as well as for pure gamma detection only. Dielectric behavior of insulators have been also discussed to achieve an optimal efficiency. Experimental results, construction and analysis of the response of these detectors are presented. (auth)

48279 COMPUTER METHOD FOR THE EVALUATION OF THE OPTICAL PROPERTIES OF SCINTILLATION DETECTOR ASSEMBLIES. Falk, F. (Inst. of Physics, Uppsala); Sparrman, P. Nucl. Instrum. Methods; 85: 253-8(1970).

The methods used in a computer program for the evaluation of the influence of optical parameters on the properties of scintillation detectors (scintillator and light guide) are described. The detectors considered are cylindrically symmetric, as used in lens spectrometers for electrons, for example. The results of the calculations made for fourteen differently designed scintillator and light guide assemblies indicate that the geometrical design and the reflective coating of the scintillator have predominant influences on the performance of the assembly. (auth)

48280 HYDROGEN ATOM DETECTOR FOR ENERGIES BETWEEN 10 keV AND 30 eV. Katrib, Ali; Abbe, Jean-Charles; Paulus, Jean-Marie (Centre National de la Recherche Scientifique, Strasbourg). Rev. Phys. Appl.; 5: 269-73(Apr 1970). (In French).

For a given energy, between 10 keV and 30 eV, the secondary electron emission on copper beryllium alloys used in electron multipliers are equal for H^+ and H. For a beam of H atoms obtained by charge transfer the calibration of the multiplier is easy and the sensitivity is a few hundreds of atoms $cm^{-2}s^{-1}$. (auth) (France)

48281 MEASUREMENT OF HALF-LIFE PERIODS WITH MULTICHANNEL ANALYZERS. Gammel, R. (Siemens AG, Karlsruhe, Ger.). Atomwirt., Atomtech.; 15: 390-2(Aug 1970). (In German).

Simultaneous measuring of half-lives of several radionuclides by means of a multichannel analyzer frequently yields more information than single determinations. This is not only true for physical half-lives but also for the measuring of biological half-lives that increasingly play an important role in diagnostic nuclear medicine. With the multichannel analyzer, up to eight scintillation detectors can be handled simultaneously. Seven block diagrams are included. (H.B.G.)

48282 MEASURING APPARATUS FOR RADIATION PROTECTION. DEVELOPMENT LINES IN THE EUROPEAN VIEW. Maushart, R. (Berthold/Frieseke Vertriebsgesellschaft fuer Messtechnik mbH., Karlsruhe, Ger.). Atomwirt., Atomtech.; 15: 378-81(Aug 1970). (In German).

Development of radiation monitoring equipment started from different points of origin in the USA and in Europe. The delayed beginning in Europe, associated with peaceful application of nuclear energy proved to be an advantage. The fact that not only Europe as a whole but also individual countries failed to reach unification of equipment was not due to measuring technique but to lack of specification of purpose for which, ultimately, legal authorities must take responsibility. Based on these facts, sharper specifications will produce instruments that are more purpose-directed, rational, and unified. (H.B.G.)

48283 PRACTICAL HAND-SHOE MONITOR. Fergus, R. W. (Argonne National Lab., Ill.). Health Phys.; 19: 307-10(Aug 1970).

A personnel hand and shoe monitor, PERCI (derived from PERsonnel Contamination Instrumentation), has been developed to provide simultaneous detection of alpha, beta and/or gamma contamination. Automatic operation provides uniform survey sensitivity that is independent of the user. Logic circuitry prevents incomplete surveys and causes "go" or "no-go" instructions to be flashed on an illuminated display panel. Alpha, beta and/or gamma events for each channel are detected with a large area gas flow detector and pulse separation circuitry. A unique background compensation feature implements statistical computation for each survey by comparing the actual number of events during the survey cycle with a number predicted from the background events preceding the cycle. Reliable operation with stable calibration is assured with solid state circuitry and appropriate feedback. Consistent performance with infrequent false alarms characterizes the operation of this monitor. Sensitivity has been demonstrated on many occasions when the monitor has detected contamination on the user that could not be located with conventional survey instruments. (auth) (UK)

48284 REACTION STUDIES WITH A POSITION SENSITIVE DETECTOR SYSTEM. Gobbi, A.; Sachs, M. W.; Wieland, R.; Reilly, W.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. pp 178-80 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

As part of a continuing program of heavy ion interaction studies, a system was developed utilizing two large, linearly position-sensitive detectors in an on-line configuration with the laboratory computer-based data acquisition system. The utility of this system was demonstrated in simultaneous measurements on the elastic and inelastic scattering in the $^{12}C + ^{12}C$ system. For each binary event, the system establishes the energy, arrival time, and angle of emission of each of the two products. These data, for accepted time coincident conditions, are subjected to on-line analysis. (M.C.G.)

48285 SCINTILLATOR-AND-FIBER-OPTICS DELAY TECHNIQUE FOR ADDRESSED MULTICHANNEL COUNTING IN DISPERSED FLUXES OF γ-QUANTA OR ENERGETIC PARTICLES. Prydz, Svein (Univ. of Oslo). Int. J. Appl. Radiat. Isotop.; 21: 545-62(Sep 1970).

A new principle of multichannel detection is proposed and discussed in which a greatly increased sensitivity seems to be obtainable for the large class of investigations where the intensity distribution in a dispersed flux of energetic particles or γ-quanta is to be measured. In principle, the improvement is that of counting simultaneously over a large part of the distribution as opposed to the normal scanning techniques where the signal results from detection through a slit of, say, only one-hundredth of the total distribution at a time. This improvement is obtained with no corresponding increase in the total noise contribution. Some inherent restrictions seem to limit the proposed method to investigations of low-intensity sources (total count rate below 1 Mc/sec). These are, however, the cases for which improvements are required. (auth) (UK)

48286 POLYETHOXYLATED NONIONIC SURFACTANTS IN TOLUENE FOR LIQUID SCINTILLATION COUNTING OF TRITIUM IN AQUEOUS SAMPLES. Lupica, S. B. (Oak Ridge National Lab., Tenn.). Int. J. Appl. Radiat. Isotop.; 21: 487-90 (Aug 1970).

Twelve polyethoxylated surfactants were examined in a toluene scintillator system (toluene to surfactant 2:1) for liquid scintillation counting of aqueous tritium samples and the results were compared to a system using Rohm and Haas' Triton X-100. Of the surfactants tested, only Monsanto's Sterox DJ and GAF's Igepal CA720 gave counting efficiencies higher than those with Triton X-100. The effects of micellization and solubilization of water by polyethoxylated nonionics are discussed. A comparison of the ir and NMR spectra of some of the surfactants indicated that those compounds showing relatively simple spectra produce less quenching and have higher tritium counting efficiency. (auth) (UK)

48287 AUTOMATIC QUENCH CORRECTION BY CHANNELS RATIO FOR BOTH ^{14}C AND TRITIUM USING A THREE CHANNEL LIQUID SCINTILLATION COUNTER. Glass, D. S. (Imperial Chemical Industries Ltd., Billingham, Eng.). Int. J. Appl. Radiat. Isotop.; 21: 531-44(Sep 1970).

Calibration of a three-channel liquid scintillation counter for sample and external standard channels ratio quench correction is described. Calibration curves, enabling both carbon-14 and tritium activities to be corrected for quenching without altering instrument settings, are modelled by computer. Data from the counter can be processed rapidly using a ready-access desk-top computer. The advantages of the method, the potential accuracy obtainable, and some applications are discussed. (auth) (UK)

48288 UTILIZATION OF SEMICONDUCTOR DETECTORS FOR RADIOACTIVITY MEASUREMENTS. Van Rooy, J. (Quartz et Silice, Paris). Neue Tech., B; 10: 210-16(1968). (In French).

A short description of the principal characteristics of the semiconductor detectors for radioactivity measurements is presented. The different types of these detectors are examined and the possibilities of their application are presented. (auth)

48289 IMPROVEMENTS IN OR RELATING TO SEMICONDUCTOR RADIATION DETECTOR ARRANGEMENTS. Owen, Richard Bruce; Salmon, Percy George; Awcock, Mervyn Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,202,197. 12 Aug 1970. Filed 14 Oct 1966.

A detector arrangement is described that comprises a body of n-type Si, having on one surface a resistive film which forms a stable rectifying contact to the Si and on the opposite surface a conductive film that forms an ohmic contact. Means for conducting current are provided at opposite ends of the resistive film together with means for determining the relative proportions of charge transferred to the resistive film in response to an ionizing event collected at the two current conducting means, and hence the position on the resistive film at which the ionizing event occurs. The resistive film may be comprised of a noble metal, and Pd is preferred. This arrangement is designed to overcome the disadvantage of short resistive film life associated with conventional detectors of this type. One end of the resistive film may be earthed. Various amplifier, bias and indicating arrangements are also described. (UK)

48290 METHOD AND APPARATUS FOR CALIBRATING RADIATION DETECTION AND MEASUREMENT INSTRUMENTS. Bolster, Michael S. U. S. Patent 3,519,821. 7 Jul 1970. Filed 15 Aug 1966.

This application discloses an improved apparatus and method of calibrating instruments used for detecting and measuring radiation such as that emitted by radioactive materials. An X-ray unit is used in combination with radiation instrument holding means and a remote indicator to calibrate an unknown instrument after first correlating the X-ray control settings to the values read on a known instrument placed in the instrument holding means. Detailed instructions for carrying out the method are disclosed. (auth)

48291 WELL LOGGING SYSTEM. Langford, Obie M. (to Texaco Inc.). U. S. Patent 3,518,623. 30 Jun 1970. Filed 24 Apr 1967.

A system for logging a corehole traversing earth formations is described wherein a logging tool, or sonde, connected to an end of an electrical cable traverses the borehole. The tool, or sonde, contains nuclear or radioactivity logging apparatus such as, for example, a scintillation detector including a photomultiplier and associated circuitry for generating output information signals representing at least one parameter (e.g., nature of subsurface formations or strata) within the traversed portion of the borehole. A 60 cycle AC power supply at the earth's surface sends power down the cable to provide the input power necessary for driving the logging apparatus. Concurrently, the information signals are sent up through the cable in superimposed relation with the AC power supply voltages. At the earth's surface there is also provided a network, or circuitry, which presents a low impedance to the information signals and a high impedance to the AC power supply voltages. Afterward, the isolated information signals are amplified, clipped and delivered to signal, or pulse, analyzing equipment in correlative relationship to the depth of the sonde in the borehole. (auth)

48292 SCINTILLATOR FILMS FOR PROTON DETECTION. Swindells, Frank E.; Crawley, James E.; Lanier, William R. (Melpar, Inc., Falls Church, Va.). Contract NAS 5-21033. Rev. Sci. Instrum.; 41: 1517-18(Oct 1970).

A method for preparation of thin films (0.5 to 2 μ) of zinc sulfide phosphors for detection of protons of energy below 100 keV against a background of x rays and electrons is described. (W.H.K.)

48293 BLANKING METHOD FOR CONTINUOUS CHANNEL ELECTRON MULTIPLIERS. Heppner, Richard A.; Donnelly, Denis P. (Univ. of Michigan, Ann Arbor). Rev. Sci. Instrum.; 41: 1504-5(Oct 1970).

One means of improving the gain characteristics of a Channeltron is to prevent unwanted particles incident on the Channeltron from being detected. This can be done with a simple blanking technique if the undesirable particles are bunched in time as they

are in certain cyclic experiments. One approach to blanking is to construct a detection system in which there are two detectors, one to provide initial detection at low gain and the second to provide a high gain for the output pulse. With such a configuration the coupling between the two detectors can be controlled. A two-detector blanking method is described. (W.H.K.)

48294 SOFT PARTICLE SPECTROMETER IN THE ISIS-I SATELLITE. Heikkila, W. J.; Smith, J. B.; Tarstrup, J.; Winningham, J. D. (Univ. of Texas, Dallas). Rev. Sci. Instrum.; 41: 1393-1402(Oct 1970).

The soft particle spectrometer uses electrostatic deflection for simultaneous measurement of the differential energy spectra of electrons and protons. The energy range is from 10 eV to 10 keV per unit charge with ±40% energy spread. Twelve stage BeCu electron multipliers are used as detectors in the counting mode over a five decade dynamic range. A swept mode of energy selection provides a spectrum in 0.5 sec for high fluxes, while a stepped mode suitable for lower fluxes takes 40 sec. A typical spectrogram for a transpolar pass is included as an example of the data reduction procedure used. (auth)

48295 ABSOLUTE DETECTOR FOR SHORT DURATION BURSTS OF IONS. Zwally, H. Jay (Univ. of Maryland, College Park, Md.). Rev. Sci. Instrum.; 41: 1489-92(Oct 1970).

Nonrepetitive bursts of ions, several microseconds in duration, with intensities less than 10^3 ions per burst were measured by a linear signal from the ninth PM dynode in a Daly-type secondary emission detector. The signal height was proportional to the number of ions and was calibrated for various ion species to an estimated absolute accuracy of ±15% and relative accuracy of ±5% between identical detectors. (auth)

48296 NEW METHOD OF REGISTRATION OF IONIZING-PARTICLE TRACKS IN CONDENSED MATTER. Dolgoshein, B. A.; Lebedenko, V. N.; Rodionov, B. U. (Moscow Engineering Physics Inst.). JETP Lett. (USSR) (Engl. Transl.); 11: 351-3 (5 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 513-16 (5 Jun 1970).

A charged particle registration method, based on the emission of electrons from a liquid into a gas, is described. As the charged particle traverses the liquid dielectric medium (liquid argon), the free electrons produced are accelerated by an applied electric field. The electron image of the track is thus transferred to the liquid–gas interface, and the electrons go from the liquid into the gas as a result of electrostatic emission. The electron image of the track is registered in the gas by any one of various methods. A multifilament proportional detector is suggested. (W.H.K.)

48297 AUTOMATIC SAMPLE CHANGER WITH 6 DETECTORS FOR MEASUREMENT OF NEUTRON SAMPLES. Graf, H.; Urech, D.; Utzinger, E. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Neue Tech., B; 11: 54-7(1969). (In German).

Neutron physics measurements in subcritical or critical assemblies rely to a large extent on the use of activation foils which are placed in the fuel, moderator or structural material. During an experiment, dozens of foils can be irradiated at the same time. For that reason a counting device with automatic sample changing and data handling is needed. In this article an automatic sample changer unit developed at EIR is described. It has 6 detector locations and is able to handle up to 60 samples. (auth)

48298 REDUCTION OF THE CURRENT OF THE PHOTOELECTRON AMPLIFIER IN THE ACTION OF GAMMA- OR X-RAY RADIATION. Timofeev, L. V.; Bochkarev, V. V.; Degtyarev, S. F. (Inst. of Biophysics, Moscow). Med. Radiol., 15: No. 9, 73-7(Sep 1970). (In Russian).

For the elimination of additional (above the scintillator current) current of the photoelectron amplifier, occurring under the effect of gamma- or x-ray radiation, the authors propose to use a lead glass as a means of light conduction. For substantiating this method the authors studied such characteristics of lead glass as weaking of roentgen radiation, character of passage of light, luminescence of glass, etc. This method enables the design of small-size monitors and eliminates the occurrence of secondary effects in the photoelectron amplifier. (auth)

48299 NEW GRAVITATIONAL RADIATION DETECTORS. Weber, J. (Inst. for Advanced Study, Princeton, N. J.). Lett. Nuovo Cim.; 4: 653-8(3 Oct 1970).

The design of gravitational radiation detectors is discussed. The discussion covers piezoelectric coupling, feedback amplifier shot noise, input impedance, noise originating in feedback resistance, noise power ratios with the feedback amplifier, and linearity requirements. Also discussed are the synchronous square-law detector, voltage regulation, stability, and noise measurements. (J.F.P.)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 48456.

48300 (BNWL-1307(Pt.2), pp 31-9) RADIATION INSTRUMENTATION: RADIOLOGICAL CHEMISTRY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

The development of radiochemical instrumentation and analytical technology, their utilization in radioisotope studies of environmental samples, their application to neutron activation analysis to define stable element versus radioelement behavior, and their use in the elucidation of the routes described by natural, tracer, or waste radioisotopes in the environs are discussed. (auth)

48301 (IITRI-578-P-33-18) DEVELOPMENT OF NEUTRON SPECTROMETRY FOR CRITICAL FACILITIES. Final Report, October 1, 1968–March 31, 1970. Semmler, R. A. (IIT Research Inst., Chicago, Ill.). May 1970. Contract AT(11-1)-578. 83p. Dep. CFSTI.

The development of a wall-less proton-recoil proportional detector for neutron spectroscopy in critical assemblies is described. Topics include the electronic system, detector characteristics, program for data reduction, neutron flux measurements in the ATSR, combining the wall-less detector and pulse-shape discrimination techniques, and detector deficiencies, Gamma rejection, energy calibration, pileup rejection, and the geometrical efficiency of a cylindrical wall-less proportional detector are discussed. (W.H.K.)

48302 (RLO-2225-T-17-1) THE MEASUREMENT OF DELAYED NEUTRON ENERGY SPECTRA. Progress Report, February 1, 1970–August 1, 1970. Woodruff, Gene L. (Washington Univ., Seattle. Dept. of Nuclear Engineering). Aug 1970. Contract AT(45-1)-2225. 15p. Dep. CFSTI.

Progress in the development of a system for the measurement of delayed neutron energy spectra is reported. The target irradiation system, data acquisition and storage, and data analysis are discussed. Proton-recoil ionization chambers are used. (W.H.K.)

48303 TIME OF FLIGHT TO KINETIC ENERGY CONVERTER FOR A NUCLEAR PARTICLE SPECTROMETER. Sleege, Gary A. (to United States Atomic Energy Commission). U. S. Patent 3,519,822. 7 Jul 1970. Filed 10 Aug 1967.

A device for converting the time of flight, t, of nuclear particles of mass m over a distance, D, into a voltage having a magnitude proportional to the kinetic energy of the nuclear particles is described. A voltage generator synchronized with the start of the time of flight of the nuclear particles produces a voltage proportional to $\frac{1}{2}mD^2/t^2$. This voltage is sampled and stored in a pulse height analyzer at the end of the time of flight of a nuclear particle. (auth)

48304 ANALYSIS OF GAMMA RAY ENERGY SPECTRUM FOR CONSTITUENT IDENTIFICATION. Moran, James H.; Tititman, Jay (to Schlumberger Technology Corp.). U. S. Patent 3,521,064. 21 Jul 1970. Filed 17 Feb 1967.

In the particular embodiment of the invention described herein, the neutron capture gamma ray spectrum of an unknown earth formation material is analyzed by matching it with a composite spectrum made up of weighted spectra of known constituent materials. To accomplish this, a multichannel pulse height analyzer separates the spectrum of the unknown material into selected energy bands and supplies information representing the gamma ray intensity in each band to a computer which determines the proportions of known constituents providing the best composite spectrum match with the unknown material spectrum. This invention relates to nuclear well logging systems for determining the nature of formations through which a well bore passes and, more particularly, to a new and improved system for identifying the constituents of a formation by analysis of gamma ray energy spectra. (auth)

48305 MAGNETICALLY PULSED TIME-OF-FLIGHT NEUTRON SPECTROMETER. Mook, Herbert A. Jr.; Wilkinson, Michael K.; Clark, Grady W.; Bates, Donald D. (to U. S. Atomic Energy Commission). United States Patent 3,517,193. 23 Jun 1970. Filed 29 Aug 1968.

A time-of-flight neutron spectrometer is provided which em-

ploys a magnetic pulser for chopping a neutron beam. The pulser is a ferrite crystal which is provided with a properly oriented magnetic drive coil. The crystal is biased with a constant low-value magnetic flux at right angles to flux lines produced by the drive coil thereby reducing the inherent neutron scattering in a Bragg-type reflection along the direction of the pulsed beam. The drive coil is pulsed by current obtained by selectively switching the energy stored in a pulse forming network. The atomic magnetic moments of the ferrite crystal are reoriented by the magnetic field pulse thus maximizing the magnetic scattering or reflecting properties of the crystal during the application of the pulse and thereby providing a neutron beam monochromator and pulser. The neutron pulse width and repetition rate can be easily varied by changing the current pulse to the drive coil. (auth)

48306 DIGITAL FILTER FOR RESOLUTION IMPROVEMENT. Cohn-Sfetcu, S. (Inst. for Atomic Physics, Bucharest); Caprini, M.; Manof, A. Nucl. Instrum. Methods; 85: 329-32(1970).

A digital filter for improving the resolution of spectra composed of overlapping lines is presented, an emphasis being laid on the possibilities of diminishing both the oscillations of the response and the inherent decrease of the signal to noise ratio. (auth)

48307 MEDIUM ENERGY NEUTRON TIME-OF-FLIGHT SPECTROMETER. I. INSTRUMENTATION. Baker, C. A. (Rutherford High Energy Lab., Chilton, Eng.); Batty, C. J.; Bonner, B. E.; Ford, P.; Friedman, E.; Tschalaer, C.; Williams, L. E.; Clough, A. S.; Hunt, J. B. Nucl. Instrum. Methods; 85: 259-67(1970).

The time-of-flight facility used for the measurement of neutron spectra from (p,n) reactions in conjunction with the Rutherford Laboratory 50 MeV proton linear accelerator is described. The energy of neutrons in the range 5 to 50 MeV produced in (p,n) reactions by 30 or 50 MeV protons can be measured over the angular range from 0° to 80° in 5° steps with an additional position available at 2°. A 10 m flight path is used which together with a typical time resolution of 1.2 nsec (fwhm) gives an overall energy resolution of 1.2 MeV for 50 MeV neutrons and 0.55 MeV for 30 MeV neutrons. (auth)

48308 MEDIUM ENERGY NEUTRON TIME-OF-FLIGHT SPECTROMETER. II. NEUTRON DETECTION EFFICIENCY OF ORGANIC SCINTILLATORS. Hunt, J. B. (Queen Mary Coll., London); Baker, C. A.; Batty, C. J.; Ford, P.; Friedman, E.; Williams, L. E. Nucl. Instrum. Methods; 85: 269-76(1970).

The absolute detection efficiency of neutron counters using NE102 plastic scintillator in the energy region from 5 to 40 MeV has been measured using a difference technique. The results are compared with calculated values and with similar measurements made elsewhere. (auth)

48309 PULSED MODERATOR STUDIES USING A TIME FOCUSSED CRYSTAL SPECTROMETER. Graham, K. F.; Carpenter, J. M. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods; 85: 163-71(1970).

A technique is reported for measuring the joint time and energy dependence of the rate of emission of slow neutrons emerging from moderators pulsed with fast neutrons. A crystal spectrometer selects neutrons of a given energy and the leakage flux of that energy is examined as a function of time. The spectrometer is arranged to be time-focussed; time resolution is decoupled from energy, spatial and angular resolution. Time-focussing enables measurements to be made using a 14 MeV neutron source of 10^{11} n/sec peak intensity. Time widths for several polyethylene moderators are reported. The leakage spectra as a function of energy are also measured using conventional time of flight techniques. The absolute yield per incident neutron is measured. (auth)

48310 PERFORMANCE OF AN INEXPENSIVE, VERSATILE, SPLIT-ANNULUS NaI SPECTROMETER. Parks, G. H.; Young, F. C. (Univ. of Maryland, College Park). Nucl. Instrum. Methods; 85: 173-80(1970).

The response of an inexpensive split-annulus NaI spectrometer has been studied with both Ge(Li) and NaI center detectors. In the escape-suppression mode the Compton continuum is reduced by approximately a factor of two compared to a singles measurement. Measurements of the relative efficiency as a pair spectrometer have been made for γ rays from 1.63 to 9.17 MeV. Studies have been made of the pair response of the center detector for contributions to the annihilation spectra in the annular detectors from more than just the full energy peak. Calculations of the efficiency of the pair spectrometer have been made and are consistent with the measurements. (auth)

48311 TROCHOIDAL BETA-RAY SPECTROMETER. Allan, C. J. (Univ. of Manitoba, Winnipeg). Nucl. Instrum. Methods; 85: 181-7(1970).

A trochoidal β-ray spectrometer has been constructed at the University of Manitoba. The instrument has a high detection efficiency and unambiguously separates positrons and electrons. Energy determination is made with Si(Li) detectors. The resolution at 500 keV is ≈6 keV fwhm at a full energy peak detection efficiency ≈20%. The spectrometer has been built for use as a pair spectrometer and has a pair peak detection efficiency $\approx 10^{-2}$ at a resolution ≈15 keV fwhm for $E_\gamma \leq 3$ MeV. (auth)

48312 NUMERICAL OPTIMIZATION AS APPLIED TO DESIGN OF MAGNETIC SPECTROMETERS. Groth, T. (Uppsala Univ.). Nucl. Instrum. Methods; 85: 189-204(1970).

Numerical optimization techniques are applied to the design of magnetic particle focusing devices. It is shown how various problems during the design work, which by conventional methods would involve a considerable amount of work, can be favorably solved by a computer. The programs are built on different modules for magnetic field calculations, integration of particle trajectories and calculation of optical properties. The optimization techniques are illustrated mainly by the application to flat air-cored spectrometers. By replacement of the magnetic field calculation module, the routines apply directly to iron-core flat spectrometers as well. (auth)

48313 OPTIMIZED FIELDS FOR DOUBLE-FOCUSING β-SPECTROMETERS. Groth, T. (Uppsala Univ.). Nucl. Instrum. Methods; 85: 205-9(1970).

Computer methods are applied to the optimization of high-aperture, double-focusing fields. The design objectives are defined by the aberration parabolas calculated by numerical integration of particle trajectories and are reached by varying the expansion coefficients of the field in the symmetry plane. The focal plane behaviour of various fields is investigated. (auth)

48314 EVALUATION OF EXPOSURE DUE TO TERRESTRIAL GAMMA-RADIATION BY RESPONSE MATRIX METHOD. Minato, Susumu; Kawano, Minoru (Nagoya Univ., Japan). J. Nucl. Sci. Technol. (Tokyo); 7: 401-6(Aug 1970).

This paper describes an analytical method for determining terrestrial γ-radiation through conversion of the pulse-height distribution obtained with NaI(Tl) scintillator into a true incident photon spectrum by means of a response matrix method. The resulting true spectrum also serves as basis for estimating the exposure rate from the same radiation. The value of exposure rate estimated by this method is compared with that measured with an ionization chamber, revealing good agreement between the results. (auth)

48315 Si(Li) DETECTOR SYSTEM FOR CONVERSION COEFFICIENT MEASUREMENTS AND APPLICATION TO THE DECAYS OF ^{51}Cr AND ^{87}Y. Carter, H. K.; Hamilton, J. H. (Vanderbilt Univ., Nashville). Z. Phys.; 235: 383-90(1970).

An electron detector system with a 3 mm × 100 mm² Si(Li) detector with a cooled FET and vacuum air lock for changing sources was constructed. The absolute efficiency was measured as a function of energy for use in the measurement of K conversion coefficients. With the Si(Li) and a Ge(Li) detector, the K conversion coefficient of the 320-keV transition in ^{51}V was measured to be 0.00156 ± 0.00008 where the K conversion coefficients of the 661- and 279-keV transitions in ^{137}Ba and ^{203}Tl were used as standards. From absolute detection efficiency measurements, the K conversion coefficients of the 388- and 483-keV transitions in ^{87}Sr were measured to be 0.16 ± 0.02 and 0.0024 ± 0.0003, respectively. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 48347, 49354, 49659, and 49660.

48316 (CALT-68-255) A HODOSCOPE/SPECTROMETER FOR HIGH-ENERGY PHOTONS. Heusch, C. A.; Kline, R. V.; Prescott, C. Y.; Yellin, S. J. (California Inst. of Tech., Pasadena. California Univ., Santa Cruz). [1969]. Contract AT-(11-1)-68. 19p. (CONF-700902-5). Dep. CFSTI.

From International Conference on Instrumentation for High Energy Physics, Dubna, USSR.

In conjunction with an experimental project that demands the best possible resolution of both the trajectory and the energy of photons in the energy region between 0.15 and 0.7 GeV, we developed a detection system which combines Cherenkov and wire chamber techniques to yield the relevant kinematical parameters in this region, but is applicable up to very high energies. The essential features are the use of lead glass for photon conversion as well as for energy detection, with interleaved wire chambers giving the desired information on shower location. Addition of

signals from the converters to that from the main lead glass block was found to result in pulseheight information equivalent in precision to that obtained from a single lead glass block. Trajectory information is obtained by reconstructing the conversion vertex from shower tracks in several subsequent wire chambers, with an accuracy depending on the geometry used. This detector scheme is widely variable in geometry and composition, and will adapt easily to given experimental requirements. (auth)

48317 (INS-TCA-27) CALCULATION OF THE EFFECTIVE AREA IN A HORIZONTAL AIR-SHOWER OBSERVATION DEVICE. Nagano, Motohiko (Tokyo Univ. (Japan). Inst. for Nuclear Study). Jun 1970. 20p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

The effective area times solid angle for triggering the horizontal air showers is calculated for three different triggering requirements in an INS AS array. The fluctuation of the number of particles in the scintillation detector and the variation of the path length in the scintillator of 5 cm thickness for inclined showers are taken into account. (auth)

48318 (SLAC-PUB-792) AN ON LINE VIDICON SCANNING SYSTEM FOR RAPID CYCLE BUBBLE CHAMBERS. Friday, R. G.; Leith, D. W. G. S.; McShurley, D. G. (Stanford Linear Accelerator Center, Calif.). Jun 1970. 4p. (CONF-700902-3). Dep. CFSTI.

From International Conference on Instrumentation for High Energy Physics, Dubna, USSR.

A prototype vidicon scanning system, built to determine the feasibility of using integrated circuits in conjunction with video and computer equipment to scan and digitize bubble chamber pictures in real time, is briefly described and preliminary tests are outlined. (W.H.K.)

48319 (UCRL-19870) BUBBLE CHAMBER PHYSICS IN THE SEVENTIES. Trilling, G. H. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1970. Contract W-7405-eng-48. 36p. (CONF-700623-1). Dep. CFSTI.

From International Conference on Bubble Chamber Technology, Argonne, Illinois.

Recent bubble chamber work is briefly reviewed including such topics as the decay properties of hyperons, neutrino interactions, electromagnetic interactions, baryon spectroscopy, boson spectroscopy, and production mechanisms and many-particle final states. Developments which may tremendously increase the capability of the bubble chamber are discussed including hybrid systems, track-sensitive targets, and large volume chambers. (W.H.K.)

48320 NEW METHOD FOR MEASURING THE ENERGY OF GAMMA-QUANTA AND ELECTRONS (A SHOWER SPECTROMETER). Tyapkin, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 85: 277-8(1970).

A new method for the determination of the energy of gamma-quanta and electrons is presented which is based on the measurement of the intensity of secondary electrons in the region of the cascade shower maximum. At an energy above 5 GeV the proposed method ensures the energy resolution of about ±10%. The method allows the simultaneous measurement of the energy of some gamma-quanta or electrons emerging at small angles since it requires no large transversal dimensions of separate detectors in contrast to the known total absorption method. (auth)

48321 EXPERIMENTAL INVESTIGATIONS OF AN ULTRA-HIGH-ENERGY PARTICLE DETECTOR USING TRANSITION X RADIATION. Alikhanyan, A. I.; Ispiryan, K. A.; Oganesyan, A. G.; Tamanyan, A. G. JETP Lett. (USSR)(Engl. Transl.); 11: 231-3 (5 Apr 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 347-9 (5 Apr 1970).

A high-energy particle detector, based on the principle that the intensity of transition radiation is strongly dependent on the particle energy, was investigated using 0.4- to 4.0-GeV electrons from the Erevan synchrotron. The electrons pass through an aperture in a toroidal CsI(Tl) crystal scintillator of the γ spectrometer and are registered by a scintillation-counter telescope. Using a layered medium consisting of 380 plates of polyethylene with a thickness of 4×10^{-3} cm, measurements were made of electron registration efficiencies ϵ as a function of energy at different angle intervals. From preliminary results, it is concluded that γ-quantum detectors can be used to register high-energy particles with $\epsilon \approx 1.0$, and that such a detector can be used to identify particles with different masses at high resolution in the momentum region $\gtrsim 100$ GeV/c. (L.B.S.)

48322 CLOUD AND BUBBLE CHAMBERS. Henderson, C. London; Methuen (1970). 134p. 38s.

An account of the development, design and use of cloud and bubble chambers is given under the following headings: some bubble chamber photographs, introduction and history, the mechanism of drop and bubble formation, cloud and bubble chamber tracks, the physics and technology of cloud and bubble chambers, getting the physics from the film, the detection and measurement of electrons in bubble chambers, the future. (UK)

48323 HOLOGRAM INFORMATION STORAGE USING DEPTH OF RESTORED IMAGE, AND PARTICLE-TRACK RECORDING CAPACITY OF A BUBBLE CHAMBER. Turukhano, B. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 131-5(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 181-6(Jan 1970).

An analytical relationship between the depth of field of a hologram and the geometric characteristics of the hologram and the volume holographed is discussed. The depth of field of the hologram is related to the hologram, so that the resolving power of the hologram can be determined experimentally without recourse to line test patterns. The maximum information storage capacity of the hologram that can be selected on the basis of the depth of the restored image was determined. The limiting capacity of a bubble chamber to handle particle tracks is calculated on the basis of these relationships with optimum dimensions and placement of the hologram specified. (auth)

48324 ERRORS IN ESTIMATION OF TOTAL EVENTS. Knop, R. E. (Rutgers-The State Univ., New Brunswick, N. J.). Rev. Sci. Instrum.; 41: 1518-19(Oct 1970).

The total number of events recorded in an exposure of bubble chamber film may reasonably be assumed to be a Poisson distributed random variable N. N for a given exposure is determined by scanning the film to locate the events. If the scanners had 100% efficiency for locating events, determination of N would be purely a process of counting. Since we assume Poisson statistics, the error would then be assigned as $N^{\frac{1}{2}}$. In general, the scanning process has an unknown efficiency less than 100%. N may then be estimated from data obtained by doing an independent full or partial second scan. This method for estimating the total events and the errors in these quantities is briefly discussed. (W.H.K.)

Radiation Dosimeters

Refer also to abstract 49246.

48325 (INR-1164) DOSE MEASUREMENTS BY FERROUS-FERRIC, FERROUS-FERRIC WITH COPPER ADDED AND OXALIC ACID DOSIMETERS. Broshkevich, R. K.; Bulkhak, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 12p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The methods of the dose and the dose rate measurements of the ionizing radiation using three dosimeters are described. These include: 1. ferrous-ferric dosimeter for the range of doses from 1000 to 30,000 rads; 2. ferrous-ferric dosimeter with copper added for the range of doses from 0.4 to 10 Mrads; and 3. oxalic acid aqueous solution for the range of doses from 0.3 to 20 Mrads. (auth)

48326 RADIOMETRIC CALORIMETRY: A REVIEW (1970 SUPPLEMENT). Gunn, S. R. (Univ. of California, Livermore). Nucl. Instrum. Methods; 85: 285-312(1970).

Calorimetric applications and instrumentation in nuclear science and technology are reviewed, primarily for the period 1964-1969, as a supplement to an earlier review. Applications are categorized as measurement of radionuclides, gamma or particle beams, local absorbed dose, and reactor radiations. (500 references) (auth)

48327 PERSONAL FD III DOSIMETER FOR MIXED RADIATIONS. Gizea, F.; Nicolae, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 695-707(1970).

The new FD III dosimeter, which contains two monitoring systems including a dosimetric radiophotoluminescent rod and a photographic system, is presented. The photographic monitoring system only is examined. The results point out that a system of superposed multielement filters as thin sheets made of high Z elements such as Ta and Pb is suitable for a good attenuation of the film maximum sensitivity without a significant loss of sensitivity to small energy. This dosimeter which contains 4 pairs of superposed multielement filters of different sizes (Ta/Pb; Cu/Ta/Pb; Sn/Pb; Cd/Pb) a filter of Al and an open window allows an accurate determination of the γ ray doses of different energy in the presence of β rays and thermal neutrons. (auth)

48328 EXO-ELECTRON EMISSION FROM ACTIVATED $CaSO_4$ PHOSPHORS. Novotney, J.; Sporny, Z.; Binova, M. (Faculty of Tech. and Nuclear Physics, Prague). J. Phys. Chem. Solids; 31: 1412-16(Jun 1970).

Results are given of studies on the effect of activators concentration on the EEE intensity for $CaSO_4$ phosphors doped by manganese and lead. In contrast to previous work amorphous powder samples of $CaSO_4$ phosphor were used because of better sensitivity to ionizing radiation than the crystalline one. It was also found impossible to prepare monocrystalline samples doped with higher concentration of given activators than ~0.1 percent. (auth) (UK)

48329 PERFORMANCE OF GLASS DOSIMETERS AND FILM DOSIMETER IN PERSONNEL MONITORING. Yokota, R.; Muto, Y.; Miyake, T. (Tokyo Shibaura Electric Co., Ltd.). Health Phys.; 19: 315-19(Aug 1970).

It has been shown by Piesch [Proc. ENEA Symp. Stockholm (1967) p 151] and Becker [Health Phys., 14: 17 (1968)] that the performance of photoluminescent glass dosimeters is considerably better than that of film dosimeters. Similar comparisons of Japanese film dosimeters and Toshiba glass dosimeters are described under the particular climatic conditions in Japan, where both temperature and humidity are high during the period from June to September, and low from December to March. Therefore, an experiment was carried out for a period of one year under simulated routine conditions. The results agree with those of Piesch and Becker. (U.K.)

48330 CALORIMETRIC DETERMINATION OF THE COMPLETE ENERGY OF BREMSSTRAHLUNG BEAM. Ermakov, I. A. (Central Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol.; 15: No. 9, 67-72(Sep 1970). (In Russian).

The design of a total absorption calorimeter is described. The results of calorimetric measurements were compared with the values of the ionization chamber (Farmer–Baldwin dosimeter) placed in ionization maximum of a water phantom and cube from organic glass with sides— 9 × 9 × 9 cm. The intensity distribution in the lateral projection was determined with the aid of photofilms and ionization chambers. Using a 4.3 MeV linear accelerator the author obtained 3890 ± 160 erg/cm^2 per one Unit of SGSE/cm^3 in a water phantom and using a betatron with an energy of 24.5 MeV in a water phantom and cube without a filter— 5940 ± 250 erg/cm^2, and with No. 3 filter (11.5 g/cm^2 Fe)— 6150 ± 260 erg/cm^2. (auth)

48331 CALIBRATION OF E. I. L. THIN-WALLED IONISATION CHAMBERS AT LOW X-RAY ENERGIES. Clayton, C. B.; Cattrell, V. G.; Law, J.; Redpath, A. T. (Royal Victoria Infirmary, Newcastle-on-Tyne, Eng.). Brit. J. Radiol.; 43: 149-50 (Feb 1970).

The sizes of the chambers calibrated outside their design range were 35cc (6 instruments), 350cc (2), and 3.5 cc (1). A Miller 100 kV therapy unit was used to compare the chambers with a Baldwin–Farmer dosimeter calibrated at the M.P.L, and a Watson's 50 kV cp generator with a Machlett OEG-50 tube was used at the lower energies to calibrate the chambers against a free air chamber. Measurements were made with the central axis of the chambers both parallel and perpendicular to the beam. Values of kV used were 100, 45, 25 and 10. Filtration was 1.7 mm Al, 0.9 mm Al, 0.3 mm Al and 1 mm Be + 30 cm air. Values of HVT (mm Al) were 2.4, 0.83, 0.18, and 0.03. The performance of the chambers proved satisfactory outside their design range. One of the chambers subsequently calibrated a series of Geiger counters for protection measurements at low exposure rates, using a heavily filtered 13 kV cp beam with a HVT of 0.17 mm Al at exposure rates of 2 to 16 mR/hour. (UK)

48332 AN EXPERIMENTAL EXAMINATION OF A GENERAL CAVITY THEORY USING A SOLID STATE DOSIMETER. Chan, F. K.; Burlin, T. E. (Polytechnic, London). Brit. J. Radiol.; 43: 54-60(Jan 1970).

The development of cavity ionization theory is briefly reviewed. The general validity of a recent theory is investigated using a clear Perspex dosimeter. The atomic number of the surrounding medium was varied from 6 to 82. The dimensions of the dosimeter were varied from a size where the dosimeter's response was largely determined by electrons entering from the surrounding medium up to a size where the response was determined solely by the electrons generated by photon interactions within the dosimeter. No significant deviation of experiment from theory was noted over the entire range. It is concluded that the general cavity theory is valid for all dosimeters in photon fields. (auth) (UK)

48333 KREMNII-1 DOSIMETER. Krongauz, A. N.; Glezin, F. L.; Grigor'eva, G. M.; Landsman, A. P.; Lyapidevskii, V. K.; Titov, A. A. (Research Inst. of Roentgen-Radiology, Moscow. All-Union Research Inst. of Current Sources, Moscow). Med. Radiol.; 15: No. 9, 78-84(Sep 1970). (In Russian).

The authors describe a dosimeter with silicon transistor detectors for the measurement of dose energies of roentgen and gamma radiation in the range of 1 to 500 R per minute and effective energies from 6 keV to 1.2 MeV. In the range of energies from 25 to 130 keV the energy dependence is absent. The dosimeter also enables to determine the layers of half weakening with the use of special filters. The detector of complete absorption measures the absorbed doses in the energy range of 6 to 25 keV and their distribution in tissue-equivalent substance; the isotropic detector measures the dose distribution in phantoms. (auth)

Radiometric Instruments

Refer also to abstract 48234.

48334 (STI/DOC–10/112) NEUTRON MOISTURE GAUGES. A Guide-Book on Theory and Practice. Technical Reports Series No. 112. (International Atomic Energy Agency, Vienna (Austria)). 1970. 103p. IAEA $3.00.

A thorough report on the design, operation, performance, and use of neutron moisture gages is presented. Topics include use in agriculture, civil engineering, hydrology, and industry; physical phenomena involved in neutron moisture gages; theoretical models; factors that influence response; volume measured; accuracy, precision, and optimum measurement time; calibration; health and safety considerations; and factors to be considered in the selection and use of neutron moisture gages. (W.H.K.)

48335 WEB THICKNESS GAUGING AND RECORDING SYSTEM HAVING AUTOMATIC WEB EDGE SENSING. Rowe, Snowden (to Ohmart Corp.). U. S. Patent 3,518,431. 30 Jun 1970. Filed 4 Mar 1968.

A gaging and recording system is disclosed which includes a radiation source and a detector mounted on opposite sides of a sheet for bidirectional transverse motion, a reversible motor drive operatively coupled to the source and detector for driving them as a unit back and forth across the sheet in a transverse scanning path extending beyond both sheet edges, and a sheet edge sensor circuit responsive to the sudden change in the output of the detector occurring each time an edge is traversed for generating a multi-purpose control signal. The multipurpose control signal is operative to reverse the direction of the gage scanning motor when the gage moves "offsheet" to prevent unnecessary overshoot, to initiate and terminate recorder chart movement when the gage goes "on-sheet" and "off-sheet" respectively, thereby conserving chart paper by not recording the output of the detector when the detector is "off-sheet", and to switch the mode of operation of the system from an "off-sheet" mode to an "on-sheet" mode wherein the detector signal is suppressed and not suppressed, respectively, when the gage goes "off-sheet" and "on-sheet", respectively, thereby preventing hard pegging of the recorder pen when the gage goes "off-sheet" and read on air. (auth)

48336 GUIDE FOR PROBE ASSEMBLY OF PORTABLE RADIATION BACKSCATTER MEASURING INSTRUMENT. Weinstock, Jacques J.; Hay, William D. (to Unit Process Assemblies, Inc.). U. S. Patent 3,519,824. 7 Jul 1970. Filed 14 Mar 1966.

A portable radiation backscatter measuring instrument for measurement use on curved surfaces constituted by a transparent workpiece engaging a base member adapted to position a probe element normal to the surface being measured and auxiliary biasing means to maintain the probe in uniform contact with the workpiece surface irrespective of the curvature thereof is described. This invention relates generally to instruments employing beta-radiation backscatter techniques for measuring the thicknesses of thin layers or coatings of one substance on a base material or substrate having a significantly different atomic number. (auth)

48337 MONITORING RIME ACCUMULATION BY RADIOACTIVE ATTENUATION. Fowler, W. B. (Dept. of Agriculture, Wenatchee, Wash.). J. Phys., E (London); 3: 735-6(Sep 1970).

A simple density gauge was used as an open-path detector of accumulating rime. Although source activity was low (2 to 3 μg of radium) it was found adequate for measurement over the range of 0 to 7 mm water equivalent. A circular shield prevents falling snow from affecting the reading. (auth) (UK)

48338 CONTINUOUS LAYER THICKNESS MEASUREMENT OF THIN ORGANIC COATINGS ON LIGHT METALS OR ALLOYS USING AN ELECTRON BACKSCATTERING GAUGE. Roche, G. R. (Clermont-Ferrand Univ., France); Deveau, J. F.; Cunat, P. J.; Levy, P.; Boin, J.; Riss, C. Rev. Phys. Appl.; 5: 317-20(Apr 1970). (In French).

Continuous thickness measurements of thin organic coatings on light metals or alloys were performed using a beta ray backscattering gage operating in a helium atmosphere. The results

were very much improved by this method. The influences of the beta radiation energy and of the atomic number of the coating were examined. Results were given concerning the accuracy of measurement and the surface of the sample tested. (auth) (France)

48339 FUNDAMENTAL STUDY ON INDUSTRIAL MEASUREMENTS BY MEANS OF BACKSCATTERED GAMMA-RAYS. PART 3. LEVEL GAUGE USING A HORIZONTALLY BROADENED BEAM. Shibata, Keizo; Wakabayashi, Nobuo; Goto, Takao; Ueda, Katsuhiko (Kobe Univ., Japan). Radioisotopes (Tokyo); 19: 410-15(Sep 1970). (In Japanese).

For on-off type and follow-up type level gauges, the primary and scattered beams of gamma-rays were limited only to a horizontal plane between lead blocks in order to increase the counting rate from a given source without deterioration of the resolving power of the level. The gamma-ray source used was ^{137}Cs, and the detector was a NaI(Tl) scintillator 44mm in diameter and 25mm thick, shielded not only from the direct beam but also from the photons scattered once by the vessel walls. They were arranged on a horizontal plane. The vertical gaps between the lead blocks used were 10, 20 and 30mm. It has been found that the width of the gap affects both the counting rate for a full vessel and the relative sensitivity at the level to be detected. The former is affected more by the gap width on the detector side than that on the source side, and the latter vice versa. It is proposed that merits of these kinds of level gauges may be expressed by the minimum product of the radioactivity of the source and the time constant of the rate meter circuit, necessary to respond to a level change of unit length. From the values, it has been found that the above-mentioned arrangements are better than those using a narrow beam reported in a previous paper. (auth)

48340 OPTIMUM CURRENT CONCEPT IN THE OPERATION OF ELECTRON CAPTURE DETECTORS. Landowne, R. A. (American Cyanamid Co., Stamford, Conn.). Anal. Chem.; 42: 1468-9(Oct 1970).

A Varian Aerograph Model 1527B was used with 250 mCi of tritium on a foil in the concentric tube electron capture detector. The operating parameters of detector flow, detector temperature, and applied voltage were studied for determining the optimum conditions for achieving the highest sensitivity possible. (W.H.K.)

Miscellaneous Instruments and Components

Refer also to abstracts 48711, 49690, and 50253.

48341 (AECL-3654) ELECTRON CHANNELLING PATTERNS IN SCANNING ELECTRON MICROSCOPY. I. THE GENERATION OF PATTERNS IN THE JSM-II SCANNING ELECTRON MICROSCOPE. Schulson, E. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1970. 28p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

Based on the requirements of high beam current and small beam divergence at the crystal surface, three methods are described and experimental results given for generating electron channeling patterns in the JSM-II scanning electron microscope. In method 1, lens 2 is turned off and lens 1 is operated at minimum setting or is turned off, giving a beam current of $\sim 10^{-7}$ A and a divergence of $\sim 3 \times 10^{-4}$ radians. The beam size, however, is large (200 μm in diameter) and is not suited for topographical examinations. Method 2 overcomes this difficulty and provides a narrow channeling beam. In this case, lens 1 is operated at extra long focal lengths by removing the pole piece and lens 2 is set to focus the beam on the specimen to a probe diameter of ~1 to 10 μm; the criterion of divergence is satisfied by reducing the size of the aperture in lens 1. Method 3 describes a wide collimated beam (~1 mm diameter) capable of integrating out of the image all contrast arising from variations in surface features, leaving only channeling contrast. In this case, method 2 is modified by increasing the setting of the first lens (again, without pole piece) and adjusting lens 2 so that its focal length equals its object distance. (auth)

48342 (CEA-N-1324) TESTING REPORT OF AN ACCURATE DENSIMETER. Ledoux, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 18 Dec 1969. 25p. (In French).

A high precision microdensimeter is described with its ultrathermostats and its application to the measurement of heavy water isotopic titre is discussed. Tests performed with a discontinuous filling of the measurement cell are described. The stabilization time is between 10 and 15 mn for the two sensitivities of 1.10^2 and 1.10^3. For the sensitivity of 1.10^3, the measurement reproducibility is 0.02% and the accuracy with a $\frac{1}{10}$ degree temperature control is 0.05% (for a water sample) and 0.04% (for a heavy water at 99.97%). A linear law was established for the calibration curve of the various standards of heavy water with titres between 10 and 100%. The microdensimeter could be easily adapted to the continuous measurement of the isotopic titre of heavy water and to the deuteration control of resins. A better reproducibility and greater accuracy than in discontinuous measurement were found (0.01%). This device may be used in an exchange process or in production. (auth) (France)

48343 (WAPD-TM-896) ON-LINE SOLID-STATE REACTIVITY COMPUTER FOR REACTOR PHYSICS TESTING. Miller, D. J.; Shaughnessy, W. A. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Aug 1970. Contract AT(11-1)-Gen-14. 51p. Dep. CFSTI.

Reactivity changes in a nuclear reactor from the near critical condition can be measured both more accurately and more quickly by a reactivity meter than by period measurement techniques. The inverse kinetics simulator (IKS) is a small analog computer which supplies time-dependent reactivity data from an input signal directly proportional to reactor power (i.e., ion chamber current). This device has been developed and used in conjunction with reactor test programs. During these tests, its ability to give fast, accurate, reactivity data was demonstrated. (auth)

48344 DIGITAL FILTER FOR SUPPRESSING NONSTATISTICAL NOISE BURSTS IN DIGITAL AVERAGING. Goodman, Leonard S.; Salter, Forrest O. (to U. S. Atomic Energy Commission). United States Patent 3,518,414. 30 Jun 1970. Filed 31 May 1967.

A device for suppressing fluctuations in the number of pulses in successive trains of pulses which are outside of predetermined statistically expected limits by means of a comparison circuit which detects the difference between the average number of pulses in a train of pulses during a predetermined time duration and the number of pulses in the succeeding train of pulses during the same predetermined time duration is described. (auth)

48345 TOTALIZING MEMORY FOR MULTICHANNEL ANALYZERS WITH INCREASED CAPACITY. Betz, Nancy A.; Burrus, Walter R.; Lewis, Trousdale A.; Reynolds, Jay W.; Slaughter, Grimes G.; Sullivan, Joseph G. (to U. S. Atomic Energy Commission). United States Patent 3,514,763. 26 May 1970. 12 Mar 1969.

In an incrementing memory system for data rates of 10^4 words per second with a channel capacity of about 10^4, externally supplied digitized events are continuously stored in auxiliary memory units and thereafter periodically reduced to a track position and head number which uniquely defines an address of a cyclic bulk storage unit. A presorter uses the track position so as to determine where in other auxiliary storage units the head number is to be stored. These second storage units batch the information and periodically activate all appropriate heads of a cyclic bulk storage unit so as to permit readout of stored information, incrementing of the same, and restorage of the incremented information in a total elapsed time equivalent to two effective cycles of the bulk storage unit. Thus the number of random occurrences of a data word is totalized rather than storing the words themselves. (auth)

48346 TOTALIZING MEMORY FOR MULTICHANNEL ANALYZERS WITH INCREASED CAPACITY. Burrus, Walter R. (to U. S. Atomic Energy Commission). United States Patent 3,521,239. 21 Jul 1970. Filed 16 Jan 1968.

An incrementing memory system for data rates of 10^4 words per second utilizes a large capacity magnetic storage unit together with a controller and appropriate auxiliaries whereby up to several hundred words of data are batched and counted within two revolutions of the storage unit in contrast to one word at a time. A "totalizing digital memory" counts the number of random occurrences of a data word, rather than storing the word itself as in a conventional digital memory. (auth)

48347 OPTICAL RANGING DEVICE. Vonderohe, Robert H.; Doede, John H.; Lindenmeyer, Carl W. (to U. S. Atomic Energy Commission). United States Patent 3,515,486. 2 Jun 1970. Filed 22 Nov 1967.

A CW laser transmits a collimated light beam of circular cross section along a reference line to a flat rotatable mirror which reflects the beam to a curved mirror located at an object point. The curved mirror reflects the collimated light with an elliptical cross section back along its transmitted path to a beam splitter located intermediate the flat mirror and the laser along the reference line. The beam splitter divides the reflected elliptical light into two beams whose intensities are proportional to deviation of the reflected elliptical light from the reference line. Differential light

responsive means derives a signal from the dual beam output from the beam splitter to drive the rotatable flat mirror and effect axial coincidence between transmitted and reflected light. A resolver and phase comparator determine the angular rotational position of the flat mirror to provide a measure of the spatial position of the object point relative to the reference axis. This system can be used for analysis of bubble chamber film. (auth)

48348 ACCURATE, WIDE RANGE ULTRAHIGH-VACUUM CALIBRATION SYSTEM. Fowler, Peter; Brock, F. J. (Norton Research Corp., Cambridge, Mass.). Contracts NAS5-3967; NAS5-9348. J. Vac. Sci. Technol.; 7: 507-16(Sep-Oct 1970).

A new method has been investigated for ultrahigh-vacuum calibration (molecular beam calibration) of vacuum gauges and mass spectrometers over the range 10^{-6} to 10^{-15} torr with less than 5% probable error. The method is applicable, in principle, to all gases but limited in practice to gases with critical temperatures greater than or equal to that of nitrogen. It combines the techniques of pressure attenuation and molecular beaming from a nearly ideal aperture to generate a precisely known molecular density in a volume, the walls of which have a capture coefficient of near unity. The upstream (reference) pressure is measured by an instrument for which NBS has a test schedule. Direct beam to background density ratios in excess of 800:1 were measured for a 304 K argon beam. The conductance of the porous Vycor pressure-attenuating element is constant to pressures exceeding 5000 torr. Determination of the magnitude of deviations from free molecular flow as the gas mean-free path λ in the furnace approaches the furnace orifice diameter d showed no greater than ½% deviation for $\lambda/d \geq 25$. The measured density distribution in the cryopumped beam tunnel agrees with the expectations of kinetic theory. (auth)

48349 ION OPTICAL DESIGN AND FIELD-SHAPING CALCULATIONS FOR THE 180° OAK RIDGE SECTOR ISOTOPE SEPARATOR. Dagenhart, W. K.; Whitehead, T. Wilson Jr. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 85: 215-35(1970).

An analysis of the optical properties of sector magnetic fields and of the field-shaping techniques used to produce them is presented in connection with their applications to high-purity, medium-current, isotope separators. Particular emphasis is placed on the use of axially symmetric, inhomogeneous, magnetic sector fields. The Oak Ridge Sector Isotope Separator (ORSIS), which resulted from this study, has been constructed and has successfully operated at strontium beam currents of 6.4 mA for 65 h with a beam resolution of ≈3000 fwhm. This separation used natural strontium metal charge having 0.56% ^{84}Sr and produced a purified sample of 99.40% ^{84}Sr weighing 3.7 mg. The ORSIS operates with a beam-deflecting radius of 24-in., 180° of beam deflection, field inhomogeneity of $n = 0.8$, object and image distances of 100-in., acceleration voltage of 40 kV, and uses an electron-bombardment ion source which employs a side-extraction slit geometry. The optical techniques, which are being used to improve the resolution and throughput of this separator, are reported along with the projected improvement in machine performance expected from these changes. The first test model of this separator presently averages 1–7 mA of total collected beam current with isotopic enrichments ranging from 1000 to 60,000. These figures vary with the element being separated and the program emphasis. (auth)

48350 SOLID STATE FLUX STABILIZER FOR NUCLEAR MAGNETIC RESONANCE EXPERIMENTS. Packer, K. J.; Strike, A. J. (Univ. of East Anglia, Norwich, Eng.). J. Phys., E (London); 3: 746-7(Sep 1970).

A flux stabilizer is described which is suitable for use in conjunction with pulsed NMR experiments. It has an input facility which can be used to provide automatic field-frequency drift control, thus leading to both long and short term stability of the magnetic field. (auth) (UK)

48351 IMPROVED, LOW COST, SPIN-ECHO ATTACHMENT TO VARIAN HA-100 HIGH RESOLUTION NMR SPECTROMETER. Ginsburg, A.; Lipman, A.; Navon, G. (Tel-Aviv Univ., Israel). J. Phys., E (London); 3: 699-701(Sep 1970).

A solid state spin-echo attachment to the Varian HA-100 high resolution NMR spectrometer is described. Relaxation times T_1 and T_2 down to 1 ms are measured by gating and amplifying the spectrometer rf signal. Detailed circuit description and pulse sequences are given. (auth) (UK)

48352 PARALLEL PLATE ELECTROSTATIC SPECTROGRAPH. Green, T. S.; Proca, G. A. (European Space Research Inst., Frascati, Italy). Rev. Sci. Instrum.; 41: 1409-14(Oct 1970).

A description is given of a new parallel plate electrostatic spectrograph. A parallel plate electrostatic analyzer has been discussed previously, in which particles issuing from a point source on the earthed plate are deflected by the electric field and brought to a focus on that plate, provided the angle of entrance to the field is 45°. This is a simple example of the more general focusing properties of a parallel plate analyzer. From consideration of these properties, it has been found possible to select a given angle of entry into the field for which second order focusing can be attained giving rise to an angular aberration term proportional to $(\Delta\theta)^3$. Using an acceptance of ±6° a resolving power of 200 is predicted and has been obtained with a prototype. (auth)

48353 OFF-AXIS CHANNELTRON MULTIPLIER FOR QUADRUPOLE MASS SPECTROMETERS. Lester, Joseph E. (Northwestern Univ., Evanston, Ill.). Rev. Sci. Instrum.; 41: 1513(Oct 1970).

A simple modification to an EAI 250A quadrupole mass spectrometer which improves its signal-to-noise characteristics and reduces multiplier contamination is described. A model 4028 Bendix Channeltron multiplier is mounted off-axis. (W.H.K.)

48354 PRESSURE SENSOR FOR MEASUREMENT OF THE FISSION GAS PRESSURE IN FUEL ELEMENTS. Buehler, R. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Neue Tech., B; 11: 80-2(1969). (In German).

A pressure-sensor for measuring of fission product gas, released by irradiation of fuel elements, is described. This pressure sensor, in its first application at the EIR, is used in connection with a vibrated UO_2–PuO_2 test fuel element and has now operated satisfactorily during several months. The results obtained up to now are encouraging. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 50253.

48355 TRANSIENT ANNEALING OF DEFECTS IN IR-RADIATED SILICON DEVICES. Gregory, Bob L.; Sander, Howard H. (Sandia Labs., Albuquerque, N. Mex.). Proc. IEEE (Inst. Elec. Electron. Eng.); 58: 1328-41(Sep 1970).

The annealing of radiation-produced defects in semiconductor devices is discussed briefly for ^{60}Co gamma-ray and 1-MeV electron damage, and in detail for fast-neutron damage. The effects on the reordering processes of varying the material parameters and the irradiation conditions are considered. Transient annealing of neutron damage near room temperature has been investigated for a wide variety of devices, and the data are presented in generalized form to increase their usefulness to device and circuit designers. Based on the experimental results, physical models are suggested for the reordering processes which occur during the annealing of neutron damage. Electron density is shown to be the most important factor governing the rate of transient annealing. Annealing factors are estimated for very early times (1 μs) following neutron exposure. Suggestions are made to minimize the effects of transient annealing on devices. (64 references) (auth)

48356 RADIATION EFFECT ON MOS/LSI. Wu, Wei-hau (Northrop Corporate Labs., Hawthorne, Calif.). Proc. IEEE (Inst. Elec. Electron. Eng.); 58: 1382-3(Sep 1970).

The performance of Fairchild 3530 metal–oxide semiconductor/large-scale integration (MOS/LSI) integrated circuits was studied in a ^{60}Co radiation environment. The experimental results obtained indicate that the maximum gamma dose for this device is 5.6×10^4 rad. These data can serve as a reference for using MOS/LSI in military or space system applications. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

Refer also to abstracts 48606, 48677, and 48754.

48357 (TID-25501) RED CELL AND PLASMA PROTEIN LABELLING WITH ^{113m}In. Adatepe, M. H.; Penkoske, P.; Potchen, E. J. (Washington Univ., St. Louis, Mo. Dept. of Radiology). [1970]. 9p. Dep. CFSTI.

Indium binding to red cells was identified and more closely resemble iron labeled red cells than chromium labeled red cells, suggesting even that the indium is bound to the heme moiety rather than another red cell constituent. Indium labels to transferrin similar to iron and this label to transferrin can be readily blocked by gallium, scandium, and iron. These observations have implications for labeled red cells in order to perform studies for regional blood volume estimations. In addition, the blocking of the indium transferrin label with relative release of free indium has implications for increased bone deposition; however, it does not appear that a practical clinical tool using this technique will be developed because of the toxicity of the current means to block the transferrin binding capacity. The basic biologic indications of these observations suggest that indium acts more like iron in binding both transferrin and red cells and further studies on the molecular biologic significance of these observations appear warranted. (auth)

48358 DEUTERIUM: NATURAL VARIATIONS USED AS A BIOLOGICAL TRACER. Gleason, Jim D.; Friedman, Irving (Geological Survey, Denver). Science; 169: 1085-8(11 Sep 1970).

The suggestion is made that isotope tracing be carried out by monitoring the natural variations in deuterium concentrations. As an example, the natural variations in deuterium concentrations between food and water collected in Illinois and food and water collected in Colorado were used to determine the residence time of water in the blood and urine of rats. We observed not only a 5½-day turnover time of water in the blood and urine, but also evidence for the influx of water vapor from the atmosphere through the lungs into the blood. (auth)

48359 IMPORTANCE OF TRACE-ELEMENTS IN THE BIOSPHERE AND THEIR ACTIVATION-ANALYSIS. Kasperek, K.; Schicha, H.; Siller, V. (Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 15: 185-8(1970). (In German).

The importance of trace-elements in medicine and biology and three cases of their analysis are discussed: cardiac failure caused by cobalt poisoning, bronchial cancers, and the normal values in human serum. (auth)

48360 THE RADIOIMMUNOASSAY OF CIRCULATING CARCINOEMBRYONIC ANTIGEN OF THE HUMAN DIGESTIVE SYSTEM. Thomson, D. M. P.; Krupey, J.; Freedman, S. O.; Gold, P. (Montreal General Hospital). Proc. Nat. Acad. Sci. U. S.; 64: 161-7(Sep 1969).

A radioimmunoassay was developed for determining the serum levels of carcinoembryonic antigen of the human digestive system in patients with cancer of the colon and rectum. The assay is simple to perform and has a high degree of reproducibility and specificity. The test detects a concentration of 2.5 mg of carcinoembryonic antigen per ml of serum and this has provided the first demonstration of a circulating tumor-specific antigen in the sera of cancer patients. (auth)

48361 SEPARATION OF ^{131}I-LABELLED MILK PROTEINS ON SEPHADEX G-50. Abdel-Wahab, M. F. (Univ. of Khartoum, Sudan). Isotopenpraxis; 6: 85-7(Mar 1970).

A simple technique for the separation of cattle whole milk proteins is described. Labeling with nascent ^{131}I precedes the separation which is done on Sephadex G-50 by means of 0.15 M NaCl. The method depends on direct interaction between ^{131}I and whole milk at a pH 9.3 and at a temperature of 60°C. Evaluation of the separated peaks is based on continuous measurements of their radioactivities using a well-type scintillation counter. Further identification of the peaks is done by virtue of optical density and physical as well as chemical properties. (auth)

48362 RADIO-IMMUNOASSAY OF GASTRIN USING ANTISERUM TO PORCINE GASTRIN. Chan Yip, Bianca S. S.; Jordan, Paul H. Jr. (Veterans Administration Hospital, Houston, Tex. Baylor Coll. of Medicine, Houston, Tex.). Proc. Soc. Exp. Biol. Med.; 134: 380-5(Jun 1970).

Rabbits immunized with partially purified porcine gastrin conjugated to bovine serum albumin stimulated the production of porcine-gastrin antiserum of high titer. A radio-immunoassay system for gastrin is described utilizing the precipitation of antibody-bound ^{131}I-labeled iodinated synthetic human gastrin I. The sensitivity of the method permits measurement of less than 10 μμg of gastrin without the possibility of a cross-reaction with molecules having a terminal tetrapeptide similar to gastrin. The technique is capable of measuring human and canine serum gastrin. (auth)

48363 MODIFIED ISOTOPIC DILUTION METHOD FOR MEASURING THE SERUM VITAMIN B_{12} LEVEL. Shum, H.-Y. (Repatriation General Hospital, Concord, Australia); Streeter, A. M.; O'Neill, B. J. Med. J. Aust.; 1: 1144-7(6 Jun 1970).

Assaying serum vitamin B_{12} levels with ^{57}Co via a modified isotopic dilution technique is described. It is shown to give rapid reproducible and clinically useful results, which are not affected by the presence of therapeutic drugs. The range obtained with 125 normal subjects and hospital control patients was 250 to 1200 pg/ml, with a mean of 547 pg/ml. Twenty-one patients with untreated pernicious anemia gave results ranging from 42 to 246 pg/ml, with a mean of 113 pg/ml. (auth) (Australia)

48364 CLINICAL IMPORTANCE OF PLASMA GROWTH HORMONE DETERMINATIONS IN ADULTS. Frey, H.; Norman, N.; Vogt, J. H. Tidsskr. Norske Laegeforen.; 88: 2258-65 (1968). (In Norwegian).

A survey is given of the present clinical status of plasma growth hormone determinations by means of radioimmunoassay. Personal experience in the field is presented, together with a description of the laboratory procedure employed. For the diagnosis of pituitary insufficiency, the insulin-induced hypoglycemia test is mainly used. This test was found to be a very sensitive indicator of pituitary disease. A dose of 0.1 IU of insulin/gk of body weight is recommended as a standard, although 0.05 IU usually produces an adequate fall in blood sugar if the patient is not obese. Patients with primary hypothyroidism and patients with obesity respond with a normal increase in the plasma growth hormone concentration upon hypoglycemia, while in anorexia nervosa the response is erratic. Arginine infusion is a convenient screening test: it is devoid of side effects but provides a less reliable stimulus to growth hormone secretion. Lysine vasopressin, muscular exercise and a secondary rise of plasma growth hormone after oral glucose loading were found to be too unreliable for clinical use. The diagnosis of acromegaly rests primarily on the demonstration of a plasma growth hormone level that cannot be suppressed by oral glucose, which normally always gives a fall in growth hormone titer to below 3 ng/ml plasma. This test may confirm the diagnosis of acromegaly, but provides little information concerning the degree of activity of the disease. (Excerpta Med.)

48365 NEUTRON-ACTIVATION ANALYSIS IN THE STUDY OF IODINE BEHAVIOR IN THE ORGANISM. Zaichik, V. E.; Ryabukhin, Yu. S.; Mel'nik, A. D.; Cherkashin, V. I. Med. Radiol.; 15: No. 1, 33-6(Jan 1970). (In Russian).

Neutron-activation analysis of iodine is promising for the study of the thyroid gland in normal and diseased conditions in both experimental and clinical medicine. Methods for the quantitative determination of iodine in tissues of the thyroid gland and the iodine content of the fractions of the blood were worked out. The methods for the histoautoradiography of stable iodine and the double histoautoradiography for stable iodine and ^{131}I in the thyroid gland were also worked out. Certain problems for the solution of which neutron-activation analysis is especially promising, were also shown. (tr-auth)

48366 IS DOUBLE-LABELING WITH TWO LEVELS OF ^{3}H-THYMIDINE A RELIABLE METHOD FOR EVALUATING MITOTIC PARAMETERS? Galand, P.; Chretien, J. (Free Univ., Brussels). J. Nucl. Biol. Med.; 13: 87-93(Jul-Sep 1969).

Double-labeling with two levels of ^{3}H-thymidine for radioautographic measurement of S phase and mitotic cycle duration is discussed. Data are given, showing that in several instances, valid discrimination can be made between lightly and heavily labeled nuclei if the first thymidine pulse is of 1 μCi/gr, and the second one of 10 μCi/gr body weight. Proper conditions of exposure and photographic processing are to be met in order to reduce the ambiguity between the two kinds of labeling. This is explained partly

by the fact that if maximal photographic response is attained, then increasing the exposition time can only add silver grains over lightly labeled nuclei, thus reducing the difference between poorly and heavily labeled cells in the autoradiographs. Evidence is given showing that interpreting the same material by the double-labeling technique or by the cumulative labeling technique (after comparison with singly labeled homologous tissue) gives similar values for S phase and generation time. As the latter method does not depend on recognition of the poorly and heavily labeled cell populations, this constitutes further confirmation of the validity of the double labeling technique. This should however be tested when applying this method to a new type of material. (auth)

48367 ANALYTICAL METHODS BASED UPON THE PRINCIPLE OF COMPETITIVE PROTEIN BINDING OF RADIOISOTOPE-LABELED AND UNLABELED SUBSTANCES. Imura, Hiroo; Yoshimi, Teruya; Kato, Yuzuru; Endo, Jiro; Torizuka, Kanji (Kyoto Univ.). Radioisotopes (Tokyo); 18: 564-77(Dec 1969). (In Japanese).

The principle of radioimmunoassay is based on the fact that when unlabeled hormone is added to the reaction system of ^{131}I-labeled-hormone and antibody, the radioactivity of the ^{131}I-labeled complex compound decreases with the increase of the amount of unlabeled substances, so this amount can be determined when antibody-bound ^{131}I-hormone and free ^{131}I-hormone are separated. The preparation of reagents and various separation methods, such as paper chromatography and ion exchange method, are described. Radioimmunoassay has the advantages of high sensitivity that enables measuring down to 1 to 2 pg, and a high selectivity of reaction. For practical use, the radioimmunoassay of various hormones, including insulin and growth hormone, was carried out. Radioimmunoassay is applied to the determination of steroid hormone, that is to say, competitive protein binding assay, and this method is based upon the competitive reaction of ^{3}H-labeled steroid hormone and unlabeled steroid hormone with binding protein. Its sensitivity, selectivity, and reproducibility are discussed. The determination of cortisone, corticosterone, aldosterone and 17-hydroxy-progesterone was also examined. The outline of the so-called triosorb method and tetrasorb method for the test of thyroid gland function was given, also the Irosorb-59, that is the determination method for the unsaturated iron binding capacity of transferrin in blood serum. (NSA of Japan)

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Refer also to abstracts 48036, 48459, 48470, 48540, and 48752.

48368 (AERE-R-5860) DEPOSITION OF AEROSOL PARTICLES IN THE NASOPHARYNGEAL REGION OF THE HUMAN RESPIRATORY TRACT. Hounam, R. F.; Black, A.; Walsh, M. (Atomic Energy Research Establishment, Harwell (England)). Feb 1970. 30p. Dep. CFSTI (U. S. Sales Only).

Experiments were made to measure the deposition of radioactive monodisperse polystyrene particles of size between 1 and 10 μm diameter aspirated through the nose and mouth at known flow-rates. The arrangements permitted the pressure difference across the nose and mouth to be determined as deposition occurred. When, for particles of the same size, deposition is plotted against flow-rate there is considerable scatter in the results. A much closer relation is found with the pressure difference. The results show some divergence from the relation proposed by the Task Group on Lung Dynamics and an alternative working relation is suggested. (auth)

48369 (CEA-CONF-1551) FATE OF IODINE RADIOISOTOPES IN INFANTS AND ADOLESCENTS AND RESULTING RADIATION EXPOSURE. Karhausen, L. R.; Pages, J. P.; Ermans, A. M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires. Brussels Univ. (Belgium). Laboratoire de Medecine Nucleaire). 1970. 18p. (In French). (CONF-700505-6). Dep. CFSTI.

From 2nd Congress of the International Radiation Protection Association, Brighton, England.

Iodine kinetic studies were performed on two groups of subjects: 46 infants and 47 adolescents. A three-compartment model was used to determine the amount of ^{131}I in the thyroid as a function of time in case of single or chronic contamination. Four models were established one for each of the following age classes: zero to six months, six months to one year, one to two years and adolescents ten to fifteen years. Finally, these theoretical results were validated by careful studies on 30 subjects within the same age classes. Thyroid activities were watched during three to four weeks. Plasma radioiodine and protein bound iodine were measured and serial determinations of urine specific activities were made. Exposure doses resulting from absorption of an iodine radioisotope were determined. (auth) (France)

48370 (SWRHL-67-r) STATUS OF THE BIOENVIRONMENTAL RESEARCH EXPERIMENTAL DAIRY HERD, JULY 1, 1966-DECEMBER 31, 1968. Smith, Donald D. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Jul 1970. 93p. Dep. CFSTI.

A status report of the Experimental Dairy for the period July 1, 1966 through December 31, 1968 is presented. It lists changes and improvements made on the facilities; presents production and reproduction statistics; details cow and herd health problems and treatments; summarizes ^{131}I experiments utilizing the dairy herd. (auth)

48371 PLANT UPTAKE OF FISSION PRODUCTS. II. UPTAKE OF ^{90}Sr BY TRIFOLIUM AS INFLUENCED BY THE CALCIUM AND PHOSPHATE STATUS IN THE SOIL. Fredriksson, L.; Eriksson, Aa.; Haak, E. (Lantbrukshogskolan, Uppsala). Lantbrukshogsk. Ann.; 36: 19-39(1970).

Experimental data presented concerning the accumulation of radiostrontium in plants by root uptake show that the main factor influencing the accumulation of strontium in plants by root uptake at a given contamination is the content of exchangeable or labile calcium in the soil. Thus, for soils low in calcium, liming is a very effective treatment in reducing the strontium accumulation in plants. If, however, the base saturation was higher than 70% of the total base exchange capacity of the soil, then additions of calcium exerted only a small influence on the Sr accumulation in plants. Under field conditions, after some years, the residual effect of a certain amount of calcium added in lime seems to have a higher negative effect on Sr accumulation in plants than calcium added in superphosphate, presumably depending on a lower degree of solubility and leaching. (Sweden)

48372 PLANT UPTAKE OF FISSION PRODUCTS. IV. UPTAKE OF ^{90}Sr AND ^{137}Cs FROM SOME TROPICAL AND SUBTROPICAL SOILS. Fredriksson, L. (Lantbrukshogskolan, Uppsala). Lantbrukshogsk. Ann.; 36: 61-89(1970).

The reducing effect of lime on plant absorption of ^{90}Sr is due partly to its content of Ca, that dilutes ^{90}Sr in the soil, and partly to its influence on the pH value and therewith associated conditions in the soil. Plant absorption of ^{90}Sr per g Ca from lateritic soils, very low in calcium, seems to be increased by sulfate but decreased by phosphate additions. Application of $Ca(H_2PO_4)_2$ should therefore be regarded as an effective method for depressing plant absorption of ^{90}Sr from lateritic soils. Additions of lime or Ca in other inorganic compounds to soils with a Ca base saturation of more than 60% will have only a little influence on plant absorption of ^{90}Sr per g Ca. Addition to the soil of other alkaline or alkaline earth ions such as Na^+, Mg^{2+}, or Ca^{2+} may also depress plant absorption of ^{137}Cs but to a much lesser extent than K^+ does. Ammonium ion (NH_4^+) additions seem to increase plant uptake of ^{137}Cs from some soils presumably through displacement of Cs adsorbed to the soil. (Sweden)

48373 FIVE-YEAR INHALATION STUDY WITH NATURAL URANIUM DIOXIDE (UO_2) DUST. I. RETENTION AND BIOLOGIC EFFECT IN THE MONKEY, DOG, AND RAT. Leach, Leonard J.; Maynard, Elliott A.; Hodge, Harold C.; Scott, James K.; Yuile, Charles L.; Sylvester, George E.; Wilson, Herbert B. (Univ. of Rochester, N. Y.). Health Phys.; 18: 599-612(Jun 1970). (UR-49-1076).

Monkeys, dogs, and rats inhaled natural UO_2 dust of approximately 1 micron mass median particle diameter (MMD), at a concentration of 5 mg U/m^3, 6 hr per day, 5 days per week for periods up to 5 yr. Retention curves for U in the lungs and other tissues including bone were established in a program of serial sacrifice and animal replacement over the 5-yr exposure period for the dog and monkey and over a 1-yr period for the rat. The two major sites of U accumulation, the lungs and tracheobronchial lymph nodes (TLN), accounted for over 90% of the U found in the body. No evidence of U toxicity was found in body weights or mortality, in the nonprotein nitrogen levels of the blood, or in the hematologic picture. Kidney injury did not occur at the exposure level of 5 mg U/m^3 (20 × TLV or 28 × MPC_a). Fibrotic changes suggestive of radiation injury, however, were seen occasionally in the TLN of dogs and monkeys and in monkey lungs after exposure periods longer than 3 yr in tissues with estimated alpha doses greater than 500 Rads for lung and 7000 Rads for TLN. The lung and lymph node data obtained in this study show that the animal body can accumulate sufficient U from prolonged exposures to insoluble U dust at 5 mg/m^3 to create potential radiologic hazards. The lung and TLN values were high enough, in fact, to anticipate radiation hazards in these tissues from exposures at or lower than the occupational threshold limit value (TLV) (250 μg U/m^3) recommended by the American Conference of Governmental Industrial Hygienists or the MPC_a (6×10^{-11} μCi/cm^3 ≈ 180 μg U/m^3) suggested by the ICRP. (auth) (UK)

48374 PLANT UPTAKE OF FISSION PRODUCTS. III. UPTAKE OF ^{137}Cs BY TRIFOLIUM PRATENSE AS INFLUENCED BY THE POTASSIUM AND CALCIUM LEVEL IN THE SOIL. Fredriksson, L. (Lanthrukshogskolan, Uppsala). Lantbrukshogsk. Ann.; 36: 41-60(1970).

Studies were made in pot experiments of the influence of the potassium and calcium status in the soil on the absorption of ^{137}Cs by Trifolium pratense. One hundred and seventy eight different Swedish arable soils were included in the experiments. For quantitative assessment of plant absorption of ^{137}Cs as influenced by the soil factors in question, multiple regression analysis of the data was carried out. (auth)

48375 MICRODETERMINATION OF URANIUM IN TISSUES. Frigerio, N. A. (Argonne National Lab., Ill.). Int. J. Appl. Radiat. Isotop.; 21: 434-6(Jul 1970).

A sequence of methods was developed for the determination of ^{235}U in tissues which adapted itself readily to rapid determinations over the range 10^{-2} to 10^{3} nmoles U per g sample, and was used to process over 100 samples per day with accuracies of ±2 to ±6%, depending on concentration. The minimum concentration of ^{235}U detectable, about 10^{-11} moles g^{-1}, rivals the best that can be obtained fluorometrically, and with much greater ease and reproducibility. While this may be of little utility in circumstances of exposure to natural U, it may well be of interest in installations where the chief hazard is exposure to enriched material. In any case the combined methods described provide a relatively simple analytical system for studying the physiology and chemistry of U in animal tissues. (auth) (UK)

48376 KINETICS OF THE PHAGOCYTOSIS OF RADIOGOLD COLLOIDS BY THE RETICULOENDOTHELIAL SYSTEM IN THE RAT. Caro, R. A. (Univ., Buenos Aires); Ciscato, V. A.; Radicella, R. Int. J. Appl. Radiat. Isotop.; 21: 405-14(Jul 1970).

The kinetics of the phagocytosis of radiogold colloids by the reticuloendothelial system of the rat was studied theoretically and experimentally, assuming a Michaelis–Menten type kinetics and stating equations which allow the analysis of the phenomenon from a more general point of view. In order to investigate the process with dispersions stabilized by an agent other than gelatine, the disappearance curves from the blood stream of polyvinylpyrrolidone (PVP) protected radiogold colloids were determined, with mean particle sizes ranging from 25 to 195 Å, by continuous measurement of the radioactivity of the blood, using an extracorporeal blood circulation technique. The results of 114 experiments show that the plot of the half-time of disappearance (T) against the number of injected particles per kg of animal (N_{inj}) gives a straight line. They also show that the maximal rate of phagocytosis is $(4.13 \pm 0.20) \times 10^{14}$ particles per kg of animal per minute and that K_1 has a value of $(2.08 \pm 0.16) \times 10^{13}$ particles per kg of animal. When these results are compared with those obtained with gelatine protected gold colloids, it is observed that, in the case of PVP stabilized dispersions, T is generally much shorter for the same value of (N_{inj}). These differences suggest that T is not only influenced by (N_{inj}), but also by the nature of the protective agent. On the other hand, it can be shown that the values of T are not specifically modified by the mean size of the colloidal particles. These observations are discussed and tentatively explained as due to the different physico-chemical properties of the protective agents which change the rate of adsorption of the particles on the surface of, and its rate of entrance into, the reticuloendothelial cell. (auth) (UK)

48377 BIOLOGY AND ECOLOGY OF POLONIUM AND RADIOLEAD. ABSTRACTS. Proceedings of a Meeting Held on 30th April and 1st May 1970. Sutton, Eng.; Institute of Cancer Research (1970). 38p. $2.50. (CONF-700412-(Abstr.)).

Abstracts of 29 of the 32 papers presented at the symposium are given. Abstracts of three papers by D. Panov are not included. These three papers discuss the ecology of radiolead, the excretion of ^{210}Pb in urine and feces of rats following intratracheal application, and the excretion of ^{210}Pb in urine and feces of rabbits following exposure to radon and its decay products. (E.R.B.)

48378 BILIARY EXCRETION OF RADIOTHYROXINE BY THE BROOK TROUT, SALVELINUS FONTINALIS (MITCHILL). Eales, J. G. (Univ. of Manitoba, Winnipeg, Can.). Gen. Comp. Endocrinol.; 14: 385-95(Apr 1970).

Radioactivity was measured for tissues and serum of brook trout acclimated at 10°, during 72 hr following intraperitoneal injection of ^{125}I-L-thyroxine (T_4^*). By 17.5 hr the enterohepatic tissues accumulated a maximum of 38% of the injected radioactivity. Maximum uptakes for individual organs of 13.5% at 5.5 hr for liver, 18% at 28 hr for gall bladder, and 23% at 48 hr for intestine indicate a biliary excretion route for thyroxine. Paper electrophoresis and descending paper chromatography revealed negligible inorganic ^{125}I in bile. Most bile radioactivity (av. 74%) occurred as two adjacent unidentified substances at R_f 0.2–0.3. At 5.5 hr after T_4^* injection, 24% of the bile radioactivity corresponded to T_4 and possibly other thyronines (R_f 0.7–0.9), but fell to 16% (17.5 hr) and 17% (28 hr). Serum T_4^* levels, measured both as $PB^{125}I$ and by paper chromatography, decreased multiexponentially and by 72 hr most serum radioactivity was ^{125}I. Negligible serum radioactivity corresponding to the unidentified bile materials was found. It was concluded that intraperitoneally injected T_4^* rapidly enters the bloodstream and is distributed to the tissues. Considerable amounts of T_4^* are taken up by the liver and excreted into the bile and intestine, principally as some unidentified derivatives of T_4. (auth)

48379 INFLUENCE OF CHEMICAL STATE OF ^{144}Ce ON ITS METABOLISM FOLLOWING INHALATION BY MICE. Morgan, Barbara N.; Thomas, R. G.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Amer. Ind. Hyg. Ass. J.; 31: 479-84 (Jul-Aug 1970).

Mice were exposed by inhalation to aerosols containing ^{144}Ce in the form of the chloride, the citrate, or entrapped in fused-clay particles. In the form of the entrapped radionuclide, ^{144}Ce is relatively insoluble and remains predominantly in lung. When inhaled as the chloride or citrate, ^{144}Ce is more soluble in body fluids and a large fraction is translocated from lung to liver and skeleton. With all three forms, the bulk of ^{144}Ce is found in the feces. (auth)

48380 ^{85}Sr AND ^{134}Cs ACTIVITY IN MILK AFTER A SINGLE CONTAMINATION OF PASTURE. Van Den Hoek, J. (Univ., Wageningen, Netherlands); Kirchmann, R. J. Tijdschr. Diergeneesk.; 93: 1121-32(15 Sep 1968).

The development of milk activity of ^{85}Sr and ^{134}Cs after a single contamination of an old permanent pasture and a newly sown in temporary sward in the early and late phases of the grazing season has been studied. Both nuclides are rapidly secreted into milk and obtain their highest values in 4 to 7 days after the cows have access to contaminated pasture. The difference in type of pasture has no influence on the maximal activity per litre of milk. However, the decrease in concentration of strontium and cesium in milk appears to occur more slowly on temporary than on permanent pasture. The transfer coefficients for strontium (the percentage of the deposited activity per m^2 or of the activity of grass per kg dry matter respectively, which is secreted per litre of milk) remained about the same for all four experiments and varied between about 1 to 1.5% and 0.30 to 0.45% respectively. In contrast to this, the transfer coefficients for cesium have values two to three times higher for the August and September experiments; they vary from about 5 to 17% and from 2 to 4% respectively. The possible reasons for this differential behavior of cesium are discussed but a satisfactory explanation cannot be given. Finally, the health physics aspects of the results of this experiment are reviewed. (auth)

48381 EFFECT OF CONTRACTION ON MOVEMENTS OF ^{45}Ca INTO AND OUT OF RAT MYOMETRIUM. Krejci, I.; Daniel, E. E. (Univ. of Alberta, Edmonton). Amer. J. Physiol.; 219: 256-62(Jul 1970).

Electrical gradient across cell membranes of estrogen-dominated rat uteri was decreased by raising external K concentration or by adding oxytocin. Effects on ^{45}Ca fluxes and net movements from decreased electrical gradient and associated contractions were studied. When rat uteri were exposed to tracer only after initiation of isotonic contraction by high external K concentration, reduced ^{45}Ca uptake was found compared to controls. Uptake of ^{45}Ca and total Ca concentration were not decreased by high external K in experiments in which tracer was allowed to equilibrate in extracellular space before and after isotonic contraction. When contracted tissues were compared to relaxed control tissues, a small and insignificant increase in ^{45}Ca uptake per 100 mg tissue was found. Results suggest that contraction slowed diffusion of tracer through extracellular space, delaying uptake. Studies showed that efflux of ^{45}Ca was slowed by isotonic contraction when contraction was present during efflux. Results were similar during isometric contractions. Efflux of sucrose-^{14}C from tissue into bath was also slowed during contraction. Decreasing the electrical gradient across cell membranes had little measurable effect on ^{45}Ca fluxes or net content, but isotonic or isometric contractions could alter fluxes possibly by affecting diffusion path through extracellular space. Increased permeability of this smooth muscle to calcium during depolarization by high potassium concentration or by drugs is not established. (auth)

48382 STRONTIUM METABOLISM WITH SPECIAL CONSIDERATION OF GENETIC EFFECTS. Crissman, John D.;

Kirk, John H. (Air Force School of Aerospace Medicine, Brooks Air Force Base, Texas). Aeromed. Rev.; 1: 1-24(Jan 1970).

A review of the literature on the effects of radioactive strontium on metabolism and genetics is presented. The production of ^{89}Sr and ^{90}Sr by nuclear explosions and distribution by fallout are discussed. The metabolism of strontium is reviewed with regard to absorption by the gastrointestinal tract and distribution through human tissues. Factors, such as age and nutrition, that influence strontium retention in the body are discussed. Data are tabulated on tissue concentrations of ^{89}Sr relative to blood concentrations as a function of time after intravenous injection in mice. Studies on strontium kinetics in the reproductive tract of mice and rams are described. Data on intrauterine mortality rates in female mice mated to ^{89}Sr injected males and the production of radioinduced mutations are discussed. Statistics on infant mortality rates in the United States and Scandinavian countries are reviewed. In the United States the mortality rates during the first 24 hrs of life are in excess of those of other countries. The rates are lower during the post and late neonatal periods; however, the rate of decrease has been more striking in the Scandinavian countries. (H.L.W.)

48383 MEASUREMENT OF IRON ABSORPTION BY WHOLE-BODY COUNTING. Cook, J. D. (Univ. of Washington, Seattle); Palmer, H. E.; Pailthorp, K. G.; Finch, C. A. Phys. Med. Biol.; 15: 467-73(Jul 1970).

A method for measuring whole-body ^{59}Fe was evaluated which employs longitudinal scan geometry, a unique arrangement of multiple NaI(Tl) detectors, and photon measurements in the Compton region. Radio-iron was quantitated from a point source embedded in plastic pellets, from tracer localized in the gastrointestinal tract, and during movement of in vivo activity into and out of the erythroid marrow. In all instances, counting levels varied by no more than 2%. Measurements were also made for two weeks following oral and intravenous radio-iron administration, to define the day-to-day reproducibility of counting and to establish the validity of measuring radio-iron absorption and losses by this technique. The suitability of the method for measurements of iron assimilation is demonstrated. (auth) (UK)

48384 RETENTION AND LUNG CLEARANCE OF PLUTONIUM OXIDE. STRUCTURE OF ALVEOLAR MACROPHAGES. Lutz, M.; Nolibe, D.; Petahy, G.; Rannaud, J. Cl. Arch. Mal. Prof. Med. Trav. Secur. Sociale; 31: 185-96(Apr-May 1970). (In French).

Phagocytosis of inhaled plutonium oxide dusts by alveolar macrophages of rats is observed. The structure of these cells is studied before phagocytosis of these particles and after it. The alveolar macrophage may survive a sufficiently long time after the capture of radioactive particles in order that it could take care of the transport of these particles, either to the trachea, or to the ganglions. (auth) (France)

48385 MICROSCOPIC DOSE DISTRIBUTION FROM ^{125}I IN THE TOXIC THYROID GLAND AND ITS RELATION TO THERAPY. Gillespie, F. C. (Western Regional Hospital Board, Glasgow); Orr, J. S.; Greig, W. R. Brit. J. Radiol.; 43: 40-7(Jan 1970).

Known aspects of the histology of the normal and thyrotoxic thyroid glands relevant to dosimetry are described, the energies and abundances of the photon and electron emissions from ^{125}I determined, and dose distributions around ^{125}I sources of various shapes calculated. The implications of the relationships in the toxic gland between functional histology and dose distribution are discussed in the light of the proposed use of ^{125}I in the treatment of thyrotoxicosis. (auth) (UK)

48386 EFFECTS OF ALDOSTERONE ON THE INCORPORATION OF ^{32}P INTO THE NUCLEOTIDES OF HEART MUSCLE. Liew, C. C.; Gornall, A. G. (Univ. of Toronto). Can. J. Biochem.; 47: 461-6(Apr 1969).

A subcutaneous injection of aldosterone into normal rats (2 μg/100 g body weight) increased the incorporation of inorganic phosphate (^{32}P) during 1 hr into the ADP, ATP, and RNA fractions of heart muscle. Similar effects were noted using adrenalectomized rats. Neither hydrocortisone (150 μg/100 g body weight) nor desoxycorticosterone acetate (250 μg/100 g body weight) showed this effect in normal rats. An aldosterone effect was also observed in vitro using 2 ng (5.6×10^{-9} M) per milliliter of centrifuged rat heart homogenate. In the absence of exogenous substrate, there was an increased incorporation of ^{32}P into the ATP fraction but not into the RNA fraction. In the presence of pyruvate the radioactivity of both ATP and RNA was enhanced by aldosterone during a 1-hr incubation. It is suggested that the action of aldosterone on energy metabolism in heart muscle precedes RNA synthesis. (auth) (Canada)

48387 CONTINUOUS MEASUREMENT OF RADIOIODIDE ACCUMULATION IN THYROID SLICES. Jortay, A. M.; Cantraine, F. R.; Delcroix, C.; Dumont, J. E. (Univ., Brussels, EURATOM, Brussels). Int. J. Appl. Radiat. Isotop.; 21: 247-52 (May 1970).

A method of automatic continuous measurement of the evolution of radioactivity in an incubation medium, by the derivation of a fraction of the medium in a measurement cell coupled with a multichannel analyzer, is described. That circuit permits the reduction of the variability in the measurement, and with elementary corrections gives data whose quality allows later treatment by the computer to determine the parameters of a kinetic model. (auth)

48388 EFFECT OF TATHION UPON URINARY EXCRETION OF ^{203}Hg-MHP VIEWED FROM A STANDPOINT OF THE REDUCTION OF RENAL DOSE. Oshiumi, Yoshihiko; Matsuura, Keiichi (Hiroshima Atomic Bomb Hospital). Jap. J. Clin. Radiol.; 14: 663-8(Aug 1969). (In Japanese).

With the aim of reducing renal dose given by ^{203}Hg-MHP (mercurihydroxypropane) as far as possible, the acceleration of urinary excretion of ^{203}Hg-MHP by Tathion was studied in animal and clinical experiments. The results obtained were as follows: The time course of ^{203}Hg-MHP distribution into liver and kidney was examined using mice. Relative specific activity was very low in the group that received Tathion intraperitoneally in comparison with that of the control group, and became lower as time elapsed after administration. The effect of Tathion with this massive dose was comparable to that obtained by 0.015 mg/gm of BAL(British anti-lewisite). In clinical experiments, BAL of 100 mg dose was intramuscularly injected two times after intravenous injection of ^{203}Hg-MHP, and then a total 7000 mg of Tathion was administered by drip phleboclysis in daily doses of 1000 mg. Urinary excretion of ^{203}Hg was examined for 7 days after the ^{203}Hg-MHP injection. In the 11 control cases, mean daily excretion percentage and mean weekly integral excretion percentage were 1.4% and 9.9%. In 10 cases with administered Tathion, the values were 2.6% and 14.4% respectively. This result showed a slight increase of ^{203}Hg-urinary excretion in the Tathion group. These excretion percentages were examined in cases with normal renal function. Mean weekly integral excretion percentage was 10% in the control, and 24.5% in the administered group. The considerable increase of ^{203}Hg-urinary excretion was recognized in the administered group. It is known from this result that the acceleration of ^{203}Hg-MHP urinary excretion by Tathion is influenced by renal function. (NSA of Japan)

48389 COMPARISON OF ^{131}I RETENTION IN THE PLASMA OF RABBITS FED TOXIC QUANTITIES OF CUPRIC OR MOLYBDATE IONS AS SUPPLEMENTS TO A COMMERCIAL PELLETED DIET OR TO AN OATS-ALFALFA LABORATORY DIET. Pepino, A. M.; Robinson, G. A.; Chou, S. T.; Liptrap, R. M. (Ontario Veterinary Coll., Guelph). Can. J. Physiol. Pharmacol.; 47: 635-43(Jul 1969).

The retention of ^{131}I in the protein-free plasma of rabbits fed a commercial diet has been reported previously. In the present study an attempt was made to defeat this retention by feeding or by intramuscular injection of cupric acetate solution. Copper did not reverse the retention; conversely, copper was more effective in producing the retention than was molybdate. The effect of copper plus molybdate was not cumulative, nor did one ion appear to reverse the retention caused by the other. Acute starvation produced a more extensive ^{131}I retention than did highly toxic levels of copper. ^{131}I retention was also observed for rabbits fed an oats–alfalfa laboratory diet even in dietary groups receiving no added molybdate or copper. Seventy-two hours after the injection of ^{131}I, the oats–alfalfa control groups showed a ^{131}I concentration in protein-free plasma approximately 50 times that of control rabbits fed the commercial diet. The common factor in the ^{131}I retention is believed to be relative partial starvation because of nutritional deficiency or lack of palatability of the diet, or the fact that the rabbits became too ill to eat normal quantities of food. (auth) (Canada)

Radiation Effects

Refer also to abstracts 48506, 48578, 48739, 48751, 48770, 48774, 48793, 48794, and 49255.

48390 (AEC-tr-7154) RADIOBIOLOGY. Translation of Radiobiologiya; 10: No. 1, 3-160(1970). 251p. Dep. CFSTI.

The 36 articles in this cover to cover translation were abstracted previously for NSA from their original language. These abstracts appeared in Vol. 24 issue 14 of NSA as abstract numbers 27516-27518, 27529-27541, 27574, 27575, 27611-27615, 27617, 27663, 27687-27695, 27719, and 27720. (E.R.B.)

48391 (AECL-3611) BIOLOGY AND HEALTH PHYSICS DIVISION. Progress Report, January 1–March 31, 1970.

(Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 41p. (PR-B-85). Dep. CFSTI (U. S. Sales Only). AECL $1.00.

Reports of the biology, environmental research, and health physics branches at the Chalk River Nuclear Laboratories are included. Areas of research reported on by the biology branch include: RNA molecules; radiation biochemistry; repair of DNA in bacteria; the structure of nucleoprotein; radiation repair in insects; microbial genetics; and vertebrate and human genetics. The environmental research branch includes research reports in the following areas: biological and physical studies; meteorological studies; chemical studies; and soil studies and radiochemical analysis. Research and monitoring activities of the health physics branch include the following areas: neutron spectra and exposure times; neutron dosimetry; thermoluminescent dosimetry; health physics instrumentation; clothing monitoring; hand held monitors; and routine film exposures. A discussion of the permissible exposures to the population at large, and the data on biological effects is presented in the topical summary. (E.R.B.)

48392 (ANL-Trans-841) CHANGES IN THE ACTIVITY OF BLOOD CATALASE AND PEROXIDASE IN THE PRESENCE OF IONIZING RADIATION. Uteshev, A. B.; Abdrakov, B. K. Translated for Argonne National Lab., Ill., from Izv. Akad. Nauk Kaz. SSR, Ser. Biol.; 7: No. 6, 75-80(1969). 8p. Dep. CFSTI.

Investigations were conducted on the activity of catalase and peroxidase and also the hemoglobin content and quantity of erythrocytes in the peripheral blood of animals possessing different sensitivity to ionizing radiation. Rats and guinea pigs were subjected to 900 R of x radiation and were killed 6, 12, 24, and 48 hrs after irradiation. A decrease in the number of erythrocytes and hemoglobin content occurred during all periods of observations. The change in the catalase activity during exposure to ionizing radiation which took place 6 hrs after irradiation of guinea pigs attained a maximum within 24 to 48 hrs. In the early period of radiation sickness, the increase in peroxidase activity of rat blood occurred in 12, 24, and 48 hrs, while these changes developed continuously in guinea pigs. The changes in chromo-protein metabolism were more significantly expressed in the guinea pig which is a more radiosensitive animal. (H.L.W.)

48393 (ANL-Trans-844) ULTRAVIOLET IRRADIATION OF RIBOSOMES: ACTION SPECTRUM OF THE INACTIVATION OF THE SYNTHESIS FUNCTION. Ekert, Bernard; Muel, Bernard; Latarjet, Raymond. Translated for Argonne National Lab., Ill., from Biochim. Biophys. Acta; 204: 275-7(1970). 6p. Dep. CFSTI.

Ribosome suspensions were exposed to uv radiation at various wave lengths and the inactivation spectrum for polyphenylalanine synthesis in the presence of polyuridilic acid was determined for each wave length. Comparison of the data with the uv absorption curves of RNA shows a difference. It was concluded that uv absorption by proteins influenced the synthesis of polyphenylalanine. (C.H.)

48394 (CEA-CONF-1559) COMPARATIVE STUDY OF THE URINARY EXCRETION OF SERINE, THREONINE, AND ETHANOLAMINE AFTER GAMMA AND NEUTRON IRRADIATION. Marble, G.; Valle, C.; Launay, C.; Petrochilo, E. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 7p. (In French). (CONF-700505-10). Dep. CFSTI (U. S. Sales Only).

From 2nd Congress of the International Radiation Protection Association, Brighton, England.

Rabbits were exposed to either γ radiation or to radiation from a simulated criticality accident (neutrons + γ). The animals irradiated by a flux of neutrons and γ-rays showed a reduction in the urinary excretion rate of serine, threonine and ethanolamine, whereas no decrease in the excretion rate of these compounds was observed after γ-irradiation alone. (auth) (France)

48395 (COO-2005-6) BIOCHEMICAL ASPECTS OF ERYTHROPOIESIS IN CHRONIC IRRADIATION. Technical Progress Report. Brambel, Charles E. (Notre Dame Univ., Ind. Dept. of Chemistry). [1969]. Contract AT(11-1)-2005. 8p. Dep. CFSTI.

Globins were isolated from non-irradiated, non-splenectomized; non-irradiated, splenectomized; and irradiated, splenectomized rats. The globins were characterized by polyacrylamide gel electrophoresis and peptide mapping. Separation of rat globin into its component chains was accomplished by column chromatography using a cation exchange resin. The globin chains were characterized with regard to absorption spectra, amino acid composition, and molecular weights. The evidence indicated that there was a significant decrease in the number of aspartic acid residues in the alpha chain of the continuously irradiated hypoxic animals compared to controls. (H.L.W.)

48396 (NYO-3797-10) PROGRESS REPORT [ON PROPERTIES OF X-IRRADIATED λ PHAGES], JANUARY 1--JUNE 30, 1970. Freifelder, David M. (Brandeis Univ., Waltham, Mass.). 15 Jun 1970. Contract AT(30-1)-3797. 7p. Dep. CFSTI.

It was shown that an x-irradiated λ phage could inject only a fragment of its DNA into bacteria. When λ DNA was fragmented to low molecular weight and centrifuged, it was found that fragments from both the left and the right ends of the phage DNA were injected with equal frequency. It was found that replication of λ DNA proceeded simultaneously to the left and right. Recombination studies showed that if the irradiation was carried out in the absence of oxygen there was a stimulation of recombination by x radiation. Deoxyribonucleic acid was released from ^{32}P labeled T7 phage and subjected to zonal centrifugation. It was shown that the terminal regions were very high in adenine and thymine. (H.L.W.)

48397 (ORO-4002-1) THE EFFECTS OF X-IRRADIATION ON THE HUMAN TESTIS: AN ELECTRON MICROSCOPIC CYTOCHEMICAL STUDY. Progress Report, November 15, 1969--November 14, 1970. Berlin, Jerry D. (Texas Tech Univ., Lubbock. Dept. of Biology). Contract AT(40-1)-4002. 16p. Dep. CFSTI.

Effects of x radiation on the ultrastructure and enzyme localization in the human testis were studied. Results showed an increased activity of acid phosphatases and thiamine pyrophosphatases and a decreased glucose-6-phosphatase activity. There was no effect on adenosine mono- or triphosphatase activity. Inosine diphosphatase was localized in the endoplasmic reticulum and the Golgi apparatus of the Sertoli cells. It was also found in cytoplasmic vesicles of spermatogonia and spermatocytes. Enzymes within cytoplasmic organelles appeared to be influenced more by irradiation than cell surface enzymes. (H.L.W.)

48398 (UCSF-10-P-2-113) DNA REPAIR AND CELL SURVIVAL IN HUMAN CELLS OF NORMAL AND XERODERMA PIGMENTOSUM GENOTYPE. Cleaver, James E. (California Univ., San Francisco. Lab. of Radiobiology). [1970]. 14p. (CONF-700610-5). Dep. CFSTI.

From 4th International Congress of Radiation Research, Evian, France.

Studies on cell sensitivity to ultraviolet light showed that the survival of fibroblasts from xeroderma pigmentosum (XP) patients was much lower than that of normal cells. The incorporation of ^{3}H thymidine into DNA during the first hour after uv irradiation was depressed to the same extent in both cell types. Repair replication was detected in both normal, heterozygote and homozygote XP fibroblasts by the incorporation of $^{3}HBrUdR$ into DNA without affecting the density of DNA. SV40 transformation did not appear to restore the low repair level of XP fibroblasts to normal levels. After treatment with chemical mutagens, XP fibroblasts repaired damage to a normal extent. (H.L.W.)

48399 EFFECT OF A CONSTANT MAGNETIC FIELD ON E. COLI ENZYME ACTIVITY. Kugot, A. S.; Oreshko, V. I.; Bocharov, E. F. (Novosibirsk Medical Inst., USSR). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk; No. 15, 137-9(1969). (In Russian).

Exposure of a culture of Escherichia coli to a constant magnetic field (150 oersteds) markedly altered the biochemical activity of the microorganism. On the 2nd day, the culture lost its ability to form indole. Saccharolytic activity gradually decreased. Before exposure to the magnetic field, the E. coli strain under study was able to decompose sucrose and form acid, and decompose lactose, mannite, and glucose forming acid and gas. On the 3rd day gas formation with lactose decomposition ceased. On the 8th day the culture was unable to decompose glucose and on the 12th day it lost all its saccharolytic properties. However, no changes were observed in the morphological, tinctorial, or cultural properties of the strain. The biochemical activity returned to initial levels after two passages on meat-peptone broth. (JPRS)

48400 IS DNA POLYMERASE INVOLVED IN DNA DEGRADATION FOLLOWING IONISING RADIATION? Trgovcevic, Z.; Kucan, Z. (Inst. Ruder Boskovic, Zagreb). Nature (London); 226: 752-3(23 May 1970).

Exposure of microorganisms to uv or ionizing radiation results in partial degradation of their DNA. In most bacterial strains irradiated with uv, the depolymerization is not very extensive and is usually considered to be part of the DNA repair system. Degradation in x- or γ-irradiated microorganisms is, however, more drastic, and it appears that the DNA breakdown is not part of the repair process. Furthermore, the repair replication of DNA observed in uv-irradiated microorganisms has not been detected after x irradiation. The degradation of DNA caused by uv and ionizing radiation might, however, be due to the same biochemical mechanisms. Studies of γ-irradiated Escherichia coli have shown

that degradation is catalyzed by pre-existing enzyme(s), and with a view to learning more about this enzyme, a chromatographic study was made of the kind of enzymic attack occurring on DNA in irradiated cells. The data obtained suggested that an exonuclease is responsible for the degradation. Analysis of the final breakdown products showed, however, the presence of some products that would not be expected by the action of an exonuclease; these may have been a mixture of small oligonucleotides. The results required an enzyme activity for the post-irradiation degradation of DNA which, until recently, would have been inconsistent with the mode of action of any known exonuclease of E. coli. Deutscher and Kornberg (J. Biol. Chem.; 244: 3029(1969)), however, described an exonuclease activity of DNA polymerase in which the principal hydrolysis products were mononucleotides and oligonucleotides. These products are formed in bacteria after ionizing irradiation, and it is suggested that the hydrolytic action of DNA polymerase is responsible for their formation. A possible mechanism is suggested. The action would result in a final loss of viability of the irradiated cell, which is the case in x- or γ-irradiated bacteria. (UK)

48401 CARBON DIOXIDE FIXATION AND TRANSLOCATION OF PHOTOASSIMILATES IN VICIA FABA FOLLOWING X-IRRADIATION. Roy, R. M.; Clark, G. M. (Univ. of Toronto). Radiat. Bot.; 10: 101-11(Apr 1970).

At 14 days post initiation of germination, seedlings of Vicia faba were exposed to 250 R of 250 kVp x ray that resulted in approximately 50% reduction in accumulation of biomass by 28 days following irradiation. The assimilation of $^{14}CO_2$ by irradiated plants during 15-min feeding periods was less than in control plants from 8 to 24 days following irradiation. Likewise, the proportion of ^{14}C-photoassimilate that was translocated to the roots of irradiated plants was significantly smaller than that of control plants from 4 to 24 days following irradiation. At 8 and 12 days post irradiation, stomatal opening on all leaves of irradiated plants was reduced relative to that of control plants and the degree of stomatal opening was found to be significantly correlated with reduced CO_2 fixation. At this time, the difference in $^{14}CO_2$ assimilation between control and irradiated plants was greater at higher light intensity, and also this difference in assimilation rate was eliminated by increasing atmospheric CO_2 to 0.09%. Evidence for a physiological limitation in CO_2 availability in irradiated plants at 8 to 12 days post irradiation is discussed in terms of the Blackman saturation effect (limiting factors) and impairment of stomatal opening. (auth) (UK)

48402 THERMAL-CHEMICAL DAMAGE IN BIOLOGICAL MATERIAL UNDER LASER IRRADIATION. Hu, Chia-lun; Barnes, Frank S. (Univ. of Colorado, Boulder). IEEE (Inst. Elec. Electron. Eng.), Trans. Bio-Med. Eng.; BME-17: 220-9(Jul 1970).

A mathematical model for thermal-chemical damage to biological materials excited by laser irradiation is described. The chemical rate equations for protein denaturization are used to predict radii of damage for cases where the input-laser-energy distribution results in the uniform heating of a small sphere or a disk. These rate equations are limited to a single-hit process. Experimental checks on this model are presented for ruby-laser irradiation of small carbon particles in egg albumin and for Co_2-laser surface heating of egg albumin. (auth)

48403 ADVANCES IN MICROBIAL PHYSIOLOGY. VOLUME 2. Rose, A. H.; Wilkinson, J. F. (eds.). New York; Academic Press Inc. (1968). 218p.

A separate abstract was prepared for one section of the book. Other sections are included on the bacterial photosynthetic apparatus, the plasmids of Staphylococcus aureus and their relation to other extrachromosomal elements in bacteria, the life cycle of bacterial ribosomes, and budding of yeast cells, their scars and aging. (H.L.W.)

For an abstract of one section see: 48404.

48404 REPAIR OF DAMAGED DNA IN IRRADIATED BACTERIA. Moseley, B. E. B. (Univ. of Edinburgh). Advan. Microbial Physiol.; 2: 173-94(1968).

A review is presented of the literature on radiation damage to DNA and mechanisms possessed by bacteria for repair of damage. Evidence that DNA is an important target in radiation inactivation was obtained from studies using Bacillus subtilis, Micrococcus radiodurans, and Escherichia coli. A review of chemical and physical changes in DNA induced by ultraviolet radiation includes studies on chain breaks, DNA cross-links, nucleic acid protein cross links, hydration of cytosine and uracil, and pyrimidine dimers. Changes induced by ionizing radiation include chain breaks and base damage. Repair of damaged DNA by photoreactivation is discussed from the standpoint of photoreactivable damage and non-photoreactivable damage. Dark repair of damaged DNA is discussed from the standpoint of recognition, incision, excision and replacement, rejoining of strands, and extent of the dark-repair mechanism in bacteria. It is emphasized that the main lesion formed on ultraviolet radiation is the pyrimidine dimer, while single and double-strand breaks are caused by ionizing radiation. (H.L.W.)

48405 MOLECULAR RADIATION BIOLOGY. The Action of Ionizing Radiation on Elementary Biological Objects. Dertinger, Hermann; Jung, Horst. Heidelberg Science Library, Volume 12. New York; Springer-Verlag New York, Inc. (1970). 245p. $6.40.

Translated by R. P. O. Hueber and P. A. Gresham.

The physical and chemical processes that lead to damage in biological molecules are examined in the 14 chapters of the book. The Hit theory is discussed with regard to basic concepts, single and multiple hit phenomena, and dose-response curves of multiple target systems. The stochastics of the action of radiation are examined with regard to kinetic interpretation of the dose-response curve, multi-hit curves, reverse processes, and dose-response curves of colony formation. Other chapters are concerned with primary processes of energy absorption, direct and indirect action of radiation, the temperature effect, the oxygen effect, the action of radiation on enzymes, physico-chemical changes in irradiated nucleic acids, inactivation of nucleic acid functions, and the action of radiation on bacteria and viruses. Numerous references are included at the end of each chapter and there is a subject index. (H.L.W.)

48406 BIOLOGICAL CONSEQUENCES OF THE PHOTOBINDING OF FUROCOUMARIN MOLECULES WITH NUCLEIC ACIDS. Musajo, L. (Univ., Padua). Ann. Ist. Super. Sanita; 5: 376-85(1969).

From Photobiology Meeting, Rome, Italy. See CONF-690552.

The biological photosensitizing properties of furocoumarins may be explained by a photoreaction between these substances and nucleic acids, which occurs when a solution containing both substances is exposed to long wavelength uv irradiation. That this photoreaction also occurs in vivo is evidenced by the fact that guinea pigs develop skin erythema when exposed to furocoumarins in the presence of uv radiation. Among the other biological photosensitizing effects reported for various furocoumarins are: lethal and mutagenic effects on bacteria; inactivation of viruses; loss of the tumor transmitting activity of Ehrlich ascites tumor cells; and protective effects of inactivated Ehrlich ascites tumor cells against subsequent challenge by untreated ascites tumor cells. All of these effects were correlated with a certain degree of photobinding of the furocoumarin tested with native DNA. (E.R.B.)

48407 REPLICATION OF DNA IN MURINE LYMPHOMA CELLS (L5178Y). I. RATE OF REPLICATION. Lehmann, A. R.; Ormerod, M. G. (Royal Cancer Hospital, Belmont, Eng.). Biochim. Biophys. Acta; 204: 128-43(1970).

The DNA of a murine lymphoma cell was pulse-labeled with radioactive thymidine for different periods of time. The cells were x-irradiated in order to introduce breaks at random into the DNA molecules, and the apparent molecular weight distribution of the labeled DNA in the denatured form was measured by rate sedimentation in alkaline sucrose. It was demonstrated that the shape and position of the radioactivity distribution on a sucrose gradient after a given x-ray dose is dependent on the length of the label in the DNA. Mathematical analysis showed that this is to be expected for a distribution of molecules of different lengths labeled only at the ends; it did not indicate that the nascent DNA has a different size from the bulk of the chromosomal DNA. The results were used to calculate the average length of label and hence the average replication rate. (auth)

48408 RADIATION EFFECTS AND ADRENAL CORTEX. V. INVESTIGATIONS ON THE "SECOND CORTICOSTEROID INCREASE" IN WHOLE-BODY X-IRRADIATED RATS. Flemming, K. (Univ., Freiburg, i. B., Heiligenberg Institut, Ger.); Geierhaas, B. Atomkernenergie; 15: 169-73(1970).

The second corticosteroid increase occurring during 2 to 4 days following irradiation was assayed in the adrenals and the blood of whole-body x-irradiated rats with doses of 500 to 10,000 R. Up to 1000 R, amount and duration of increase were dependent upon dosage. The increase was reversible; the maximum was always reached on the 3rd day after irradiation, independent of the radiation dose. Fourteen days after mid-lethal radiation doses (750 to 850 R), the corticosteroid values in the adrenals and the blood were further significantly increased. Following doses of 1000 to 10,000 R, the rate of increase was independent of radiation dosage. Values within this range reached a plateau two days after irradiation. The corticosteroid increase was irreversible and continued

until the death of the animals. As regards the cause and mechanism of the increased adrenocortical activity 3 and 14 days after irradiation, the coincidence with the gastrointestinal and hematopoetic syndrome might be of importance. (auth)

48409 EFFECT OF IRRADIATION ON VITAMIN E IN FOODS, ON TOCOPHEROL, AND ON TOCOPHEROL ACETATE. INFLUENCE OF DIFFERENT RADIATION CONDITIONS. Diehl, J. F. (Institut fuer Strahlentechnologie, Karlsruhe, Ger.). Z. Lebensm.-Untersuch. Forsch.; 142: 1-7(Feb 1970). (In German).

Vitamin E-destruction as a result of irradiation with electrons was compared in a number of foods. Losses were highest in products with high fat content. Losses of α-tocopherol in irradiated sunflower oil were not influenced by the presence of water (emulsified with Tween 80) but greatly influenced by the tocopherol concentration. Tocopherol was more radiation resistant than tocopherol acetate. The protection provided by the exclusion of atmospheric oxygen during irradiation was small with tocopherol acetate, considerable with tocopherol. With tocopherol acetate dissolved in sunflower oil or in oil-water emulsion, the exclusion of atmospheric oxygen resulted in a 20% reduction of the loss caused by irradiation. Changes of dose rate in the ratio 1:100 had no effect on the loss of α-tocopherol caused by irradiation. (auth)

48410 SOME DATA ON THE EFFECT OF X-RAYS ON HYALURONIC ACID IN ANIMAL'S BRAIN. Bregadze, M. A. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 57: 221-4(Jan 1970). (In Russian).

Both high and small doses of X-radiation induced some changes of hyaluronic acid in all the brain regions of mice and guinea pigs. The changes were primarily observed in the capillary walls, in the ventricle and the cerebellum; then in the cerebral hemispheres, in the medulla, and only later in other regions of the brain. (auth)

48411 ACTION OF URANIUM ON THE BIOSYNTHESIS OF AMINO ACIDS BY MICROORGANISMS OF THE MYCOCOCCUS GENUS. Krasil'nikov, N. A.; Koval'skii, Yu. V.; Kharat'yan, I. G. (Moscow State Univ. Inst. of Microbiology, Moscow). Vestn. Mosk. Univ., Ser. VI, Biol. Pochvoved.; 24: No. 6, 84-8(1969). (In Russian).

Chemical elements absorbed by the organisms during the weathering of rocks and the formation of the primary soil affect the synthesis of amino acids which in turn participate in the weathering process. This problem was investigated by examining the effect of uranium on the synthesis of amino acids by mycococci. Cultures of the 14 strains used in the experiments were passed through media containing uranium. It was found that the strains react differently to the presence of uranium in the system: in four cases the biosynthesis of alanine was stimulated to the extent of 160%; two strains increased the glutamic acid production almost by a factor of 2 and one strain caused a fivefold increase of alanine in the medium. Five strains had only a slight effect and three depressed the biosynthesis of the amino acids. Increase of the uranium concentration resulted in an increase of the valine in the culture. (TTT)

48412 POSSIBLE UNCOUPLING ACTION OF GAMMA-RADIATION IN EXCISED BEAN HYPOCOTYL SEGMENTS. Joshi, V. G.; Gaur, B. K. (Bhabha Atomic Research Centre, Bombay). Int. J. Radiat. Biol.; 18: 173-8(1970).

Radiation is known to act as an uncoupler of oxidative phosphorylation in animal tissues. Evidence for a similar mechanism of radiation action in plant systems is presented. This is based on a significant reduction in the uncoupling effect of 2,4-dinitrophenol (DNP) on irradiated tissue compared with that on unirradiated control. Phaseolus vulgaris seedlings were exposed to ^{60}Co γ rays at 14.3 kR/min. (UK) (TSS)

48413 POSSIBILITY OF ANION FORMATION IN IRRADIATED FROZEN SOLUTIONS OF NUCLEIC ACID BASES. Srinivasan, V. T.; Singh, B. B.; Gopal-Ayengar, A. R. (Bhabha Atomic Research Centre, Bombay). Int. J. Radiat. Biol.; 17: 577-85 (1970).

From E.S.R. spectroscopy it is suggested that purine and pyrimidine anions are formed after gamma-irradiation of their alkaline solutions at -196°C. On warming to higher temperatures, the anions usually became hydrolysed, giving rise to secondary radicals formed by hydrogen addition. A direct relation was obtained between the yields of anions and radicals, which increased with the alkalinity of the solution. On exposure to visible light, anions decayed following second-order kinetics. (auth) (UK)

48414 EFFECT OF UV IRRADIATION ON THE CAPACITY OF AN HFR RECA STRAIN OF ESCHERICHIA COLI TO ACT AS DONOR. Greenberg, Joseph; Green, Michael H. L.; Bar-Nun, Nurit (Palo Alto Medical Research Foundation, Calif.). Mol. Gen. Genet.; 107: 209-14(1970).

The ability of a recA Hfr strain of Escherichia coli to form colonies is extremely sensitive to inhibition by ultraviolet light. Furthermore, in this strain the synthesis of DNA is stopped completely by a dose of 385 ergs/mm^2 of UV. Nevertheless, the ability of this recA Hfr strain to act as a donor in sexual recombination was no more sensitive to UV than that of a wild type donor. Furthermore, when irradiated and mated with a recA female, in which DNA synthesis was also inhibited by UV, there was a net synthesis of DNA as measured by the incorporation of ^{14}C thymidine. By using nalidixic acid resistant recA donors and recipients in all combinations, irradiating with UV and treating with nalidixic acid during mating, it is shown that DNA was synthesized by the donor. It is concluded that synthesis of DNA directed by the sex factor during mating in a recA donor is not as sensitive to inhibition by UV as normal DNA synthesis in a recA donor. (auth)

48415 EFFECT OF WHOLE-BODY X-IRRADIATION ON TYROSINE HYDROXYLASE AND CATECHOLAMINE LEVELS. Van Woert, Melvin H.; Korb, Frances (Yale Univ., New Haven). Life Sci., Part I; 9: 227-32(15 Feb 1970).

Rats were x-irradiated at an exposure rate of 32 R/min and a whole-body exposure of 1800 R. At intervals up to 84 hrs after irradiation the animals were killed and the adrenals and brain were excised, weighed, and homogenized. Amino acids and catechol compounds were removed from adrenal homogenate. Tyrosine hydroxylase activity of adrenal glands and brain was assayed. Norepinephrine and epinephrine in the adrenals and brain were isolated from tissue extracts. Forty-eight hrs after x irradiation there was a decrease in the norepinephrine and epinephrine levels in the adrenal gland. The maximum decrease in norepinephrine and epinephrine and the maximum increase in tyrosine hydroxylase were seen 84 hrs after irradiation. No change was observed in levels of norepinephrine or tyrosine of the brain after irradiation. A discussion is presented of the mechanisms of control of norepinephrine synthesis. (H.L.W.)

48416 STUDY BY ELECTRONIC PARAMAGNETIC RESONANCE OF THE PHOTODYNAMIC ACTION OF PROFLAVINE ON A FEW PROTEINS. Mosora, Florentina; Milcu, Ileana; Van de Vorst, Albert (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg.; 55: 693-700(1969). (In French).

The production of free radicals in proteins by photodynamic action is shown. The systematic analysis of this phenomenon, in the case of gelatin, trypsin, pepsin, and lysozyme, photosensitized in the presence of oxygen by proflavine shows that the radicals produced are similar to those obtained by direct irradiation of these biomolecules with x rays or ultraviolet. (tr-auth)

48417 RADIATION SENSITIVITY STUDIES OF PLANT PIGMENTS. II. EFFECTS OF RADIATION ON CAROTENOID FRACTIONS OF ORANGE JUICE AND MANGO PULP. Sawant, P. L.; Ramakrishnan, T. V.; Kumta, U. S. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Bot.; 10: 169-74(Apr 1970).

The total carotenoids of tropical Indian fruits, Nagpur oranges (Mandarin variety) and Alphonso mangoes (Mangifera indica) differ widely in their sensitivity to gamma radiation. For the same radiation dose of 1.0 Mrad, carotenoids of orange juice are destroyed to the extent of 38 per cent, while those of mango pulp undergo a destruction by only 24 per cent. In the same fruit, carotenoid fractions among themselves vary in their radiation lability. New carotenoid fractions detected in the irradiated fruits indicate the possibility of mild oxidation or transformation during irradiation. (auth) (UK)

48418 CYTOFLUORIMETRIC INVESTIGATIONS OF NUCLEAR DNA-PROTEIDS IN CULTURED CELLS AFTER IONIZING RADIATION ACTION. Khamidov, D. Kh.; Khakimov, P. A.; Mamatsaliev, U. (Inst. of Biochemistry, Tashkent). Uzb. Biol. Zh.; No. 2, 7-10(1970). (In Russian).

Cytofluorometric methods were used for studies on nuclear DNA of cultured cells treated with ionizing radiation. It was found that high doses caused an increase in secondary luminescence of cell nuclei. The nuclear luminescence was influenced by DNA and proteins. (auth)

48419 EFFECTS OF X-RAYS ON PECTIN STUDIED BY ELECTRON SPIN RESONANCE. Fritsch, G.; Reymond, D. (Research Lab. for Nestle Products, Vevey, Switzerland). Int. J. Appl. Radiat. Isotop.; 21: 329-34(Jun 1970).

Radiolytic effects of x rays on apple pectin at different moisture and HCl content were measured by electron spin resonance. It is estimated that at least four free radical species exist with life-

times of more than 5 min. The formation rate of long-lived free radicals was ten times higher at 1.9 per cent moisture content as compared to a corresponding sample of 22.8 per cent moisture content. These free radicals disappeared when irradiated samples were kept at room temperature under air; their disappearance was determined at different storage times. (auth) (UK)

48420 RADIATION DAMAGE TO GRAPEFRUIT IN RELATION TO ETHYLENE PRODUCTION AND PHENYLALANINE AMMONIA-LYASE ACTIVITY. Riov, J.; Monselise, S. P.; Kahan, R. S. (Hebrew Univ., Rehovoth, Israel. Soreq Nuclear Research Centre, Yavne, Israel). Radiat. Bot.; 10: 281-6(Jun 1970).

Irradiation of grapefruit with 200 krads of gamma rays enhanced ethylene production which attained a peak 12 hr after treatment. Subsequently ethylene production rapidly decreased either to control values (fruit at early maturity), or to about 50 per cent of maximum (fruit fully ripe). Phenylalanine ammonia-lyase (PAL) activity curves followed the same patterns, but with a certain time lag. With early fruit no damage ensued; with fully ripe fruit pitting of peel occurred. Dose effects studies on fully ripe fruits, 22 and 120 hr after irradiation, showed that effects of relatively low doses (25 to 100 krads) resembled the effects of 200 krads on early fruits (a decrease of ethylene and PAL to control level, and no damage). At 400 krads ethylene production and PAL activity increased, resulting in a severe peel damage. (auth) (UK)

48421 EFFECTS OF GAMMA RADIATION AND ETHYLENE ON PROTEIN SYNTHESIS IN PEEL OF MATURE GRAPEFRUIT. Riov, J.; Goren, R. (Hebrew Univ., Rehovoth, Israel). Radiat. Bot.; 10: 155-60(Apr 1970).

Effects of gamma irradiation on protein synthesis in grapefruit peel were studied by incorporating ^{14}C-leucine into newly synthesized protein. A linear relationship was found between the increase in irradiation doses and the inhibition of protein synthesis. Four hundred krads inhibited almost completely protein synthesis. No recovery of protein synthesis was detected for 5 days after irradiation. Irradiation had little or no effect on total uptake of ^{14}C-leucine. Senescence of non-irradiated fruits was characterized by a decrease in protein synthesis, while total uptake remained unchanged. Inhibition of protein synthesis by irradiation was not affected by fruit senescence. Ten ppm ethylene did not affect protein synthesis, while 100 ppm inhibited it by 50 per cent. The relationship between protein synthesis, ethylene and irradiation-induced PAL activity is discussed. (auth) (UK)

48422 RESISTANCE OF AFLATOXIN TO CHEMICAL AND BIOLOGICAL CHANGES BY GAMMA IRRADIATION. Miyaki, K.; Aibara, K.; Miura, T. (National Inst. of Health, Tokyo). pp 57-64 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

The preliminary studies on the resistance of Aflatoxin against chemical and biological changes by γ irradiation (7, 15, or 30 Mrad) were carried out by means of thin-layer chromatography, uv absorption spectrophotometry, fluorescence spectrophotometry, and yolk sac inoculation with 5-day eggs. No marked changes were observed in the uv and fluorescence spectrum between treated and untreated Aflatoxin even on irradiation with 30 Mrad. However, a blue fluorescence spot with a smaller R_f value than Aflatoxin G_1 was clearly found after the treatment with 30 Mrad, but never in untreated samples. The spot of Aflatoxin G_1 on the TLC plate disappeared and the blue spot mentioned above was also found after the irradiation when Aflatoxin was diluted in the buffer solutions. Aflatoxin was biologically quite resistant to irradiation. Aflatoxin was, however, decomposed in some inorganic salt solutions and this tendency was accelerated by the irradiation treatment. (auth)

48423 CHANGE IN SUCCINATE DEHYDROGENASIC AND CYTOCHROMEOXIDASIC ACTIVITY OF TISSUES OF CEREBRAL HEMISPHERES IN EARLY PERIODS AFTER X-RAY IRRADIATION OF RABBITS. Shostakovskaya, I. V.; Timochko, M. F. Biol. Deistvie Radiats.; No. 4, 76-9(1969). (In Russian).

In studying changes of succinate dehydrogenase and cytochrome oxidase activity of tissues of the cerebral hemispheres in early periods following total-body x irradiation of rabbits at a dose of 400 R, it was established that irradiation was dissimilarly reflected on the activity of the enzymes of tissues of the cerebral hemispheres studied. In the first 10 min after irradiation, the succinate dehydrogenase and cytochrome oxidase activity of brain tissues was increased; 2 hr after irradiation and up to the end of the first day, the succinate dehydrogenase activity of brain tissues continued to increase, but the cytochrome oxidasic activity was reduced below the control level. Tendencies to the opposite changes in the activity of the enzymes were retained all the way to the 14th day of the investigation. (JPRS)

48424 PERCENTAGE CONTENT AND INTENSITY OF REPLENISHMENT OF CERTAIN FRACTIONS OF SOLUBLE PROTEINS OF TISSUES OF STOMACH AND DUODENUM IN RADIATION SICKNESS. Chayka, Ya. P. Biol. Deistvie Radiats.; No. 4, 31-5(1969). (In Russian).

In experiments on rabbits, the effect of ionizing radiation on percentage content and intensity of incorporation of ^{35}S-methionine in the albumin-adequate (as to lability of blood serum proteins) electrophoretic fraction of soluble proteins of mucosa and the muscle-serous layer of the stomach and duodenum was studied. A radiometric method and the agar-gel electrophoresis method with subsequent radioautography of the electrophoretograms were used. X irradiation of animals with doses of 300, 600, and 1000 R induced a sharp decrease in the percentage content of the albumin-adequate fraction of soluble proteins of mucosa and the muscle-serous layer of the stomach and the duodenum. An appreciably large decrease in the percentage content of the fraction was observed in the mucosa of the duodenum where the greatest inhibition of the intensity of replenishment of the fraction protein was also noted. (JPRS)

48425 EFFECT OF X-RAY IRRADIATION ON REPLENISHMENT OF ALBUMINS OF SOLUBLE PROTEINS OF THE LUNGS. Datskiv, M. E. Biol. Deistvie Radiats.; No. 4, 36-40(1969). (In Russian).

The agar-gel method of electrophoretic analysis combined with radioautography and radiometric investigations was used in studying proteins of the albumin electrophoretic fraction of soluble proteins of the lungs. It was shown that irradiation of rabbits with doses of 300, 600, and 1000 R led to a decrease in the percentage content of the albumin electrophoretic fraction of soluble proteins of the lungs. A reduction in the extent of incorporation of ^{35}S-methionine by albumins of soluble proteins of the lungs in early periods after irradiation of rabbits gave evidence of the disruption of the replenishment of proteins of this electrophoretic fraction. (JPRS)

48426 ACTION OF IONIZING RADIATION ON BIOSYNTHESIS OF SOLUBLE PROTEINS OF GRAY AND WHITE BRAIN MATTER. Shevchuk, Ya. G. Biol. Deistvie Radiats.; No. 4, 56-60(1969). (In Russian).

A study was made of the effect of ionizing radiation on the biosynthesis of soluble proteins of the gray and white brain matter of rabbits receiving total-body x radiation at a dose of 300 R in the dynamics of radiation sickness (first, third, sixth, ninth, 12th, 15th, 18th, and 21st day). The agar-gel method of electrophoresis combined with the labeled atom method was used. The biosynthesis of proteins was judged by the radioactivity of ^{35}S-methionine incorporated in various electrophoretic fractions. Ionizing radiation at a dose of 300 R caused a disruption of the biosynthesis of certain protein fractions of soluble proteins of the gray and white brain matter. (JPRS)

48427 DACTYLOGRAPHIC STUDY OF TRYPTIC HYDROLYSATES OF RAT HEMOGLOBIN IN ACUTE RADIATION SICKNESS. Makovetskii, N. I. Biol. Deistvie Radiats.; No. 4, 52-5(1969). (In Russian).

It has been established that tryptic hydrolysates of hemoglobins from rats irradiated with a dose of 400 × 800 R during the course of radiation sickness always yielded a large amount of peptide fragments in the cathode and neutral zones of peptide maps compared with controls. The data presented afford the finding that when ionizing radiation acts on the animal organism, the primary structure of the hemoglobin molecule is changed, which places the radiation syndrome among the pathological processes associated with molecular pathology. (JPRS)

48428 INTENSITY OF REPLENISHMENT OF ELECTROPHORETIC FRACTIONS OF SOLUBLE PROTEINS OF CARDIAC MUSCLE IN DYNAMICS OF ACUTE RADIATION SICKNESS. Kapis, M. V. Biol. Deistvie Radiats.; No. 4, 26-30(1969). (In Russian).

A study has been made of x irradiation of rabbits (1000 R) on the electrophoretic characteristics of soluble proteins of the heart (SPH) and on the intensity of incorporation of ^{35}S-methionine by their individual fractions in the dynamics of radiation sickness. The method of agar-gel electrophoresis with subsequent radioautography of electrophoretograms was used. In the electrophoretic spectrum of the SPH of intact animals, nine fractions were detected, which, as to electrophoretic mobility, generally correspond to proteins of blood serum. It was established that the intensity of replenishment of various fractions of SPH differ: the highest was observed for alpha-globulins, and the lowest for albumins, low-ionic fraction, and gamma-globulins. (JPRS)

48429 EFFECT OF IONIZING RADIATION ON STARCH. PART 2. SACCHARIFICATION AND LIQUEFACTION OF IR-RADIATED STARCHES. Umeda, Keiji; Takano, Hiroyuki; Sato, Tomotaro (Food Research Inst., Tokyo). Shokuryo Kenkyujo Kenkyu Hokoku; No. 25, 4-10(Feb 1970). (In Japanese).

When the solutions of irradiated starches (0.2%) including rice, wheat, potato, and sweet potato starches were gelatinized and saccharified with Takadiastase(0.005%), the saccharification ratio was higher by 3 to 15% than that of non-irradiated starches. This difference of saccharification ratio between non-irradiated and irradiated starches was diminished by an increase of the amount of enzyme, adjustment of pH by buffer solution, and/or addition of HCl. Amylograms of irradiated starches showed that the viscosity of irradiated starch was decreased with increasing dose of radiation. Viscosities of non-irradiated and 1 Mrad irradiated starch that had been adjusted to about B.U. 900 concentration decreased by 50 and 33%, respectively, with the addition of 3 mg of α-amylase. The viscosities of 5 Mrad or 10 Mrad irradiated starch, however, did not change with the addition of α-amylase. Amylograms of solutions of 1, 5, and 10 Mrad irradiated starches of equal concentration adjusted to pH 4.2 to 4.4 with HCl showed a constant decrease of B.U. value, but the decreasing rate against initial B.U. value was raised with the dose of radiation. The amount of terminal reducing groups of irradiated starch was increased proportionally with the radiation dose, but was scarcely influenced by the addition of α-amylase and the pH adjustment mentioned above. (auth)

48430 X IRRADIATION OF THE INNER EAR OF THE GUINEA PIG. AN ELECTRON MICROSCOPIC STUDY OF THE DEGENERATING OUTER HAIR CELLS OF THE ORGAN OF CORTI. Winther, F. Oe. (Oslo Univ., Rikshospitalet, Oslo). Acta Oto-Laryngol.; 69: 61-76(Jan-Feb 1970).

The inner ear of guinea pigs was irradiated with single doses of 7000 R x rays. An electron microscopic study of the organ of Corti was performed after 1½, 3, 4, and 6 hr. Changes were noticed in the outer hair cells of the two basal coils while the inner hair cells, the outer hair cells of the two apical coils, and the supporting cells were normal. The first changes were observed in the nuclei and consisted of clumping of the chromatin and the interchromatinic substance. Later the nuclei became pycnotic. In the cytoplasm the early changes were: increase of peculiar elements of interconnected smooth and rough endoplasmic reticulum; various mitochondrial alterations; increase in the number of glycogen-like granules; increase in the number and size of lysosome-like bodies in the apical portions of the cells and the appearance of sequesters of small cytoplasmic areas delimited by a double or a single membrane. Severely altered cells appeared shrunken. At later stages cell debris with an electron transparent matrix and numerous vacuoles were observed. No signs of phagocytosis were noticed. The elimination of the degenerated elements is presumably due to autolysis. (auth) (Sweden)

48431 EFFECT OF X-RAY IRRADIATION ON ELECTROPHORETIC CHARACTERISTICS AND REPLENISHMENT OF SOLUBLE PROTEINS OF THE LIVER. Kapis, M. V. Biol. Deistvie Radiats.; No. 4, 21-5(1969). (In Russian).

Studies have been made on the effect of sublethal ionizing radiation (300 R) on the electrophoretic characteristics and intensity of replenishment of certain fractions of soluble proteins of the liver (SPL) of rabbits in the dynamics of radiation sickness. The agargel method of electrophoresis was used in conjunction with the isotopic tracer method (^{35}S-methionine). It was established that the rate of replenishment of various fractions of the SPL differed: the highest was noted for the alpha-globulins and the lowest for the gamma- and pre-gamma-globulins. Irradiation of animals with a sublethal dose of ionizing radiation (300 R) caused quantitative and qualitative changes in the electrophoretic spectrum of the SPL, and also disrupted the intensity of replenishment of some of their fractions in different periods of time after irradiation, reflecting the course of the radiation process. (JPRS)

48432 AMINO ACID COMPOSITION OF HEMOGLOBIN OF RATS WITH RADIATION SICKNESS. Makovetskii, N. I. Biol. Deistvie Radiats.; No. 4, 46-51(1969). (In Russian).

The effect of ionizing radiation on the rat hemoglobin molecule was studied for different periods of radiation sickness caused by x-ray exposure at doses of 400 and 800 R. It was established that in the dynamics of radiation sickness, the percentage ratio of methionine, valine, serine, and phenylalanine was considerably reduced. The highest changes were observed for the amino acid cystine, whose content by the 12th day after irradiation with a dose of 800 R was reduced by 5.5 times. At different periods of the radiation sickness the glycine content was increased. (JPRS)

48433 METABOLIC STUDY OF WHOLE-BODY IRRADIATED RATS. EFFECTS OF IONIZING RADIATION IN PROGRESSIVELY INCREASING DOSES. II. COMPARTMENTS OF PROTEINS AND TOTAL LIPIDS. Bergamini, G. (Ospedale Maggiore, Trieste, Italy). Boll. Soc. Ital. Biol. Sper.; 45: 351-4(31 Mar 1969). (In Italian).

Sixty female albino rats of 200 g weight were divided as follows: Group A (six rats) served as controls; group B (15 rats) received whole-body irradiation of 500 R; group C (15 rats) got 1000 R radiation; group D (15 rats) received 1500 R; group E (15 rats) received 2000 R radiation. Groups B, C, D, and E were subdivided into subgroups containing 3 animals each that were sacrificed 1, 2, 3, 6, 24, and 48 hours after irradiation. Of each animal total serum protein was determined according to the biuret method of Kinsley–Gorwall and total serum lipids were determined according to the method of Zöllmer. The results were shown in tables and graphs. It was apparent that total serum protein of irradiated animals did not differ very much from that of unirradiated controls, though some minor variation could be observed. At low doses a somewhat higher protein value was found that subsequently adjusted itself to that of the controls. At high irradiation doses a sudden, but minor, increase that subsequently adjusted itself to that of the controls was observed. Generally, however, changes of total serum protein were not significant. As far as lipids are concerned, the situation was different. A constant increase in time with respect to the controls was observed. Very high radiation doses, however, increased the lipid content of the blood serum much slower than low radiation doses. (F.J.W.)

48434 METABOLIC STUDY OF WHOLE-BODY IRRADIATED RATS. EFFECTS OF IONIZING RADIATION IN PROGRESSIVELY INCREASING DOSES. I. COMPARTMENTS OF GLYCEMIC VAL VALUE. Bergamini, G. (Ospedale Maggiore, Trieste, Italy). Boll. Soc. Ital. Biol. Sper.; 45: 349-51(31 Mar 1969). (In Italian).

The effects of high irradiation on the intermediate metabolism of rats was studied. As indicators for carbohydrate metabolism served glycemia, pyruvenia, and hepatic glycogen. As indicators of protein metabolism, total protein content of blood and its content of individual amino acids after chromatographic separation was determined. For lipid metabolism served total blood lipid content, chromatographically separated lipid fractions and lipid content of liver, spleen, heart, and kidneys. The rats were subdivided into the following groups: Group A served as control. Group B (18 rats) received 500 R whole-body x radiation, Group C (18 rats) received 1000 R radiation. Group D (18 rats) received 1500 R radiation. Group E (18 rats) received 2000 R radiation. Groups B, C, D, and E were divided into subgroups to be sacrificed 3, 24, and 48 hours after irradiation. The glycemic values were determined according to the method of Cerrotti. They were shown in a table. The evolvement of sugar in blood serum (mg/100 ml) during the 48 hours after irradiation was shown in a time chart. No statistically significant difference could be found in the sugar content of the blood with respect to various levels of whole-body irradiation. The outstanding fact is that in all irradiated rats the glycemic values reached a maximum after 24 hours. (F.J.W.)

48435 STUDIES ON THE CHEMICAL BASIS OF CELLULAR RADIOSENSITIZATION BY 5-BROMOURACIL SUBSTITUTION IN DNA. I. PULSE- AND STEADY-STATE RADIOLYSIS OF 5-BROMOURACIL AND THYMINE. Zimbrick, J. D.; Ward, J. F.; Myers, L. S. Jr. (Univ. of California, Los Angeles). Int. J. Radiat. Biol.; 16: 505-23(1969).

Pulse- and steady-state radiolysis techniques were combined in a comparative study of the radiation chemistry of aqueous oxygen-free solutions of 5-bromouracil (BU) and thymine (T). The results show several important differences in the radiolysis of these two molecules, which may form the chemical basis of BU sensitization. The hydrated electron (e^-_{aq}), $\cdot CO_3^-$, and certain organic radicals destroy BU by reactions which yield a uracilyl radical and Br^-. In contrast, these species are not important in T destruction. The uracilyl radical is a transient species having a weak absorption maximum at 335 nm. It is very reactive, being able to abstract H· from a variety of molecules to form uracil and to propagate a chain reaction in formate BU solutions. (auth)

48436 ANALYSIS OF THE TARGET THEORY OF LEA WITH MODERN DATA. Marshall, M.; Gibson, J. A. B.; Holt, P. D. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Int. J. Radiat. Biol.; 18: 127-38(1970).

The target theory of Lea has been re-examined using modern data. Various workers have obtained radiation cross-sections from the data given in Lea's book. These cross-sections are different for different radiations and are in many cases larger than the physicochemical cross-sections. Energy transfer between molecules has been postulated by some authors to explain this. However, before making this assumption, it is necessary to use the best available data to find the effect on the calculated cross-sections. Lea's data were calculated for water, whereas in this

paper calculations have been made for protein. The differences are small (~10 per cent) except in the case of the stopping power for low-energy electrons and the cross-section for primary ionization. The stopping power for low-energy electrons is not known, and modern experiments show that the primary ionization in protein may be much larger than in water. Various assumptions have been made about these in the calculations. The sensitivity of an ideal protein to lightly and heavily ionizing radiation has been calculated using various models for the stopping power for low-energy electrons and the primary ionization. The results indicate that, for reasonable assumptions about these parameters, the cross-sections obtained from the radiation sensitivity of a molecule will be smaller than those calculated from Lea's data and therefore closer to the physicochemical cross-sections. (auth) (UK)

48437 PHYSICAL PARAMETERS OF RADIATIONS DETERMINED FROM THE INACTIVATION OF RIBONUCLEASE. Marshall, M.; Holt, P. D.; Gibson, J. A. B. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Int. J. Radiat. Biol.; 18: 139-46(1970).

In a previous paper the target theory of Lea was examined and the data required by the theory were modified. Several assumptions were made about the stopping power for low-energy electrons and the molecular cross-section for primary ionization. An experiment with the enzyme, ribonuclease, has been performed to determine which assumptions give consistent results. The effects of α, deuteron, γ, and proton radiations on the enzymic activity of the ribonuclease have been found. The exponential decrease in activity with dose in all cases indicates that a single-hit process is involved. Cross-sections have been calculated by the modified Lea theory. Consistent values of the cross-section of ribonuclease have been obtained for a specific value of the parameter used to calculate the primary ionization (M = 0.3), and for a certain model of the stopping power of low-energy electrons (dE/dx follows the Bethe–Bloch theory for $E \geq 400$ eV and $dE/dx \propto E^{-0.5}$ for $E < 400$ eV). The average cross-section of $(8.4 \pm 0.2) \times 10^{-14}$ cm^2 is close to the physical cross-section of 8.5×10^{-14} cm^2. Using the same parameters the cross-sections of lysozyme, trypsin and desoxyribonuclease have been obtained from results of Brustad. The implications of the results are discussed. (auth) (UK)

Immunology

Refer also to abstracts 48631, 48666, 48668, 48683, 48702, and 48707.

48438 (TID-25490) TRANSPLANTATION IMMUNITY: EFFECT OF RADIATION AND RELATED STUDIES. Progress Report, July 1, 1969–June 30, 1970. Hume, David M. (Medical Coll. of Virginia, Richmond. Dept. of Surgery). Contract AT(40-1)-2459. 25p. Dep. CFSTI.

The immune response to transplantation and the effect of radiation in altering this response are examined. At present two methods, local graft irradiation and extracorporeal radiation of blood, are utilized in clinical organ transplantation. Related studies of transplantation immunology are examining in vitro the reactions of both cell-bound and serum antibody upon target cells in tissue culture, and the modification of this reaction by immunosuppressive agents as chemotherapy, antilymphocyte serum, and radiation. Laboratory studies are also being conducted into the evaluation of histocompatibility. Techniques of orthotopic hepatic transplantation in dogs were developed. Present studies are in evaluation of several immunosuppressive regimens as well as the evaluation of metabolism by the transplanted liver. The latter includes immunoglobulin production and the bile acid/phospholipid production, as well as the effects upon hematopoiesis. Other studies include examination of the renin–angiotensin system in patients with renal failure and following renal transplantation; visualization of transplanted organs with radioisotopes; dosimetry and shunt geometry of beta applicators for extracorporeal blood irradiation. (auth)

48439 PRESENCE OF LIFE-SHORTENING FACTORS IN SPLEENS OF AGED MICE OF LONG LIFESPAN AND EXTENSION OF LIFE EXPECTANCY BY SPLENECTOMY. Albright, J. F.; Makinodan, T.; Deitchman, Julia W. (Oak Ridge National Lab., Tenn.). Exp. Gerontol.; 4: 267-76(Dec 1969).

Spleen cells of aged (C57BL/6 × C3H)F_1 mice, when transferred into middle-aged x-irradiated mice of the same strain, severely reduced the survival of the recipients. This life-shortening effect became progressively greater with increasing age of the donor mice. In contrast, splenectomy of mice of interjacent ages sustained life; under the experimental conditions it nearly doubled the remaining life expectancy. Although the influence of the spleen on survival remains to be explained, the action of the age-related spleen factors on progenitor cells may cause the steady decline in immunologic capacity with advancing age. (auth)

48440 FUNCTION OF THE IMMUNE RESPONSE IN TUMOR GROWTH AND ITS GENETICAL REGULATION. A NEW HYPOTHESIS. Spaerck, J. V. (Statens Scruminstitut, Copenhagen). Acta Pathol. Microbiol. Scand.; 77: 1-23(1969).

Studies on the role of the immunological reactions of the host organism in the growth of transplanted tumors are reported. An experimental system was used that consisted of strictly inbred C3H mice as recipients of mammary carcinomas from syngeneic (C3H) or allogeneic (DBA) donors. In order to secure well-defined genetical relations, only primary, spontaneous tumors were transplanted. Tumors were implanted subcutaneously as cell suspensions and the development of the tumor was recorded. Whole-body x-irradiation and cortisone injections were used as methods for reducing the immunological responsiveness of the recipients. These experiments have shown that the effect of a depression of the immune response is a reduced tumor growth, provided that the donor and recipient are of identical genotype. If genetic differences are involved in the donor-host combination, the effect of immunosuppression is the reverse, viz. a prolonged persistance of tumor before the final regression. These findings indicate that, when the genetic conditions make the development of tumor possible, the tumor growth is not a function of a defective immune response of the host. In continuation of this demonstration, experiments were carried out to elucidate the problem whether the cells of the transplanted tumor originated from the cells of the graft or from the host. By using recipient mice that were either chimaeras of two strains of mice or hybrids between them, and homozygous tumor donors from one of the strains, an experimental system was obtained in which the tumor would grow, but in which cells of donor and host origin could be distinguished on antigenic markers. Both by transplantability tests and by a serological technique, it could be shown that the tumor in this system acquired the properties of the host. It was found by the direct cytotoxic test that practically all the recovered cells reacted as host cells. The immunological and genetic findings reported suggest a hypothesis that explains the tumor formation as a reaction phenomenon, viz. a particular form of inflammatory proliferation of the host mesenchyme that is transformed into tumorous structures. (auth)

48441 MECHANISM OF A HETEROLOGOUS, CUTANEOUS GRAFT-VERSUS HOST REACTION IN MICE. Brune, K. (Univ., Basel). Z. Gesam. Exp. Med.; 151: 74-88(Sep 1969). (In German).

A cutaneous, heterologous graft-versus host reaction (GVHR) in x-irradiated mice was induced by injecting rat lymphocytes. The reaction displays the same characteristics as those described for homologous GVHR. Intensity and duration of the reaction depend on the irradiation of the host and on the quality and quantity of the injected rat-cells. The reaction could be modified by influencing selectively the host or the graft with antimouselymphocytic serum (AMLS) or antiratlymphocytic serum (ARLS). AMLS increased and prolonged the reaction. ARLS suppressed it. The mechanism of the reaction was characterized as follows. It is a strictly unidirectional GVHR and the fade out is caused by the immunological recovery of the host. The qualitative influence of AMLS or ARLS may offer a new method for the standardization of antilymphocyte serum. (auth)

48442 DIFFERENTIATION OF ROSETTE-FORMING CELLS FROM MYELOID STEM CELLS. Edwards, G. E.; Miller, R. G.; Phillips, R. A. (Univ. of Toronto). J. Immunol.; 105: 719-29 (Sep 1970).

Evidence is presented that the myeloid and lymphoid systems of the adult mouse are derived from a common stem cell. Ionizing radiation was used to induce unique chromosome markers in individual stem cells of the myeloid system. This marked stem cell was injected into genetically anemic mice of genotype W/W^v and repopulated their myeloid systems with chromosomally marked cells. To determine whether or not cells of the lymphoid system also contained the chromosome marker, we purified rosette-forming cells from the spleens of mice bearing a marker. Mice were immunized with sheep erythrocytes (SRBC), and at the peak of the secondary immune response a spleen cell suspension was prepared. Cells in this suspension were allowed to bind SRBC and form rosettes, and the rosette-forming cells (RFC) were purified by velocity sedimentation. The RFC population appears to include all antibody-producing cells, but the converse may not be true. Karyotype analysis of the purified rosettes showed a high frequency of chromosomally marked cells, indicating that some RFC can be derived from stem cells that can also differentiate into myeloid cells. These stem cells are probably pluripotent and able to give

rise to RFC of many specificities. RFC specific for SRBC were found among the progeny of all the clones examined. It is highly unlikely that stem cells with restricted specificity would give such a result. The simplest interpretation is that there exist in bone marrow of adult mice pluripotent stem cells able to differentiate into functional cells of both the myeloid and lymphoid systems. (auth)

48443 INITIATION OF ANTIBODY RESPONSES BY DIFFERENT CLASSES OF LYMPHOCYTES. II. DIFFERENCES IN THE TISSUE DISTRIBUTION OF LYMPHOCYTES INVOLVED IN PRIMARY AND SECONDARY ANTIBODY RESPONSES. Strober, Samuel (National Cancer Inst., Bethesda, Md.). J. Immunol.; 105: 730-3(Sep 1970).

Thoracic duct cells and spleen cells from normal and immunized Lewis rats were injected into syngeneic recipients which had received 500 R x-irradiation 2 hr earlier. Tetanus and diphtheria toxoids were injected 24 hr after irradiation and the antibody response was measured for 2 to 3 weeks thereafter. Immunologically competent units were detected in normal spleen cells but not in normal thoracic duct cells. Immunization of the cell donors produced at least a 10^3- to 10^4-fold increase in units in the thoracic duct lymph and a much smaller increase in units in the spleen resulting in a change in the distribution (relative concentrations) of units in these lymphoid tissues. (auth)

48444 STUDIES ON THE CELLULAR IMMUNE RESPONSES OF SYRIAN HAMSTERS TO TRANSPLANTATION ANTIGEN EXTRACTS. Zakarian, Siraik. Philadelphia; Univ. of Pennsylvania (1969). 154p.

Thesis.

Extracts prepared from Polyoma virus-induced tumor cells of CB hamster origin (P 147#8 CB TAE) contain immunogenetically active substances when tested in homologous strains of Syrian hamsters. When emulsified in Complete Freund's Adjuvant (CFA) and inoculated in the foot pads of homologous hosts, P 147#8 CB TAE elicits strong immunity against the CB transplantation antigen(s). Immunity was tested for by the accelerated tumor and skin graft rejection, inlaid homograft rejection, and the direct reaction. The direct reaction test was utilized in measuring potency of antigenic extract preparations in hyperimmune hosts and in measuring the degree of immunity evoked in normal homologous hosts with lymph node cells or antigenic extracts introduced intracutaneously, intraperitoneally, intravenously, or by injection into the foot pads. In regard to the capacity of antigen extracts to elicit sensitivity measured by the direct reaction, the foot pad route was most effective and the intravenous least effective. From comparative studies on the antigenic capacities of TAE prepared from various tissues, tumor and cheek pouch epidermal cell extracts were found to be superior to lymph node and spleen, thymus, liver, kidney and red blood cell extracts. The donor-recipient combination used in this investigation differs in regard to only one strong histocompatibility antigen and therefore activity measured represents response to that one major antigen. Lymph node cells from hamsters sensitized with P 147#8 CB TAE in CFA are capable of transferring homograft immunity detectable by the transfer reaction that is indistinguishable from reactions produced by lymph node cells from hamsters sensitized with skin homografts. Systemic adoptive transfer of immunity with cells from hosts sensitized by means of antigenic extracts was also possible, but only with large numbers of cells of the order of 100×10^6 cells. Exposure of normal lymphoid cells to transplantation antigen extracts in vitro at 4°C alters their behavior in such a way to suggest a transformation of these cells in vitro into an immune state. Such cells, unlike normal unincubated lymphoid cells, are capable of inciting transfer reactions in vivo as well as tumor target cell destruction in vitro. Whether this altered reactivity of antigen incubated cells is indeed the consequence of in vitro sensitization is not clear and experiments with antigen supplemented transfer reactions in normal isologous and irradiated hosts emphasize the possibility of antigen-cell interaction resulting in transfer reactions in the skin test area or for that matter an increased in vitro tumor target cell destruction. Finally, exposure of adult hamsters to large doses of transplantation antigen extracts administered intracutaneously and intraperitoneally over a period of five weeks will bring about a non-responsive period—tolerance—in these hosts to subsequent homologous tissue grafts. Furthermore a single whole-body dose of radiation (300 R) in combination with a single intravenous injection of 130×10^6 cell equivalents of TAE will prolong homograft survival past the normal median survival time of homografts in untreated hosts. It is concluded that: the non-soluble transplantation antigen extracts prepared from normal and malignant hamster tissues are capable of evoking a state of specific immunity in normal homologous hosts; this immunity is transferable by means of viable lymphoid cells adoptively and in the transfer reaction; incubation of normal cells with antigen extract in vitro results in what seems to be a transformation in vitro of the normal cells into an immune state; and exposure of normal or irradiated adult hamsters to large doses of antigen results in their tolerance of subsequent tissue homografts of donor type. (Diss. Abstr.)

48445 ASSOCIATION OF AMERICIUM WITH FERRITIN IN THE CANINE LIVER. Stover, Betsy J.; Bruenger, F. W.; Stevens, W. (Univ. of Utah, Salt Lake City). Radiat. Res.; 43: 173-86(Jul 1970).

In the canine liver ^{241}Am(III) is distributed ubiquitously at the subcellular level. Significant concentrations were measured in the hepatic connective tissue, the nuclear fraction, the cytosol, the mitochondrial fraction, and the microsomal fraction, and increase in the order given. In the cytosol most of the americium is bound by ferritin. It was also bound by lipofuscin, which was identified histochemically, and by an unidentified material with a molecular weight of 1500. ^{241}Am-ferritin was isolated in pure form by gel electrophoresis. (Since ferritin that is heavily loaded with iron is found in the microsomal fraction, the high concentration of americium observed in the microsomal fraction could be an anomaly.) The transfer of americium from transferrin to ferritin was shown to occur in vitro as is the case with ^{239}Pu(IV). Partial identification of ^{239}Pu-ferritin in hepatic cytosol was also achieved. Two concurrent mechanisms for the elimination of americium and plutonium from the liver are described, and the relationship to decontamination therapy is suggested. (auth)

48446 RADIOSENSITIVITY OF IMMUNOLOGICALLY COMPETENT CELLS. Price, Gerald B.; Makinodan, T. (Univ. of Tennessee, Oak Ridge. Oak Ridge National Lab., Tenn.). Trans. N. Y. Acad. Sci.; 32: 453-7(Apr 1970).

From a minimal level three days after irradiation of mice, the recovery of immunocompetence after 250 R of x irradiation followed a characteristic pattern for steady-state systems. There was approximately a 10-day period of no new increase in immune potential, i.e., an abortive phase with subsequent increase and overshoot of the normal level. There was no indication of a radioresistant immunocompetent cell population when the system was in a state of flux induced by radiation or in a senescing state. (auth)

48447 PERIPHERAL LEUKOCYTE CHANGES IN SHEEP AFTER BLOOD REPLACEMENT FROM IRRADIATED DONORS. Souto, Jose; Anderson, Donald L. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-Gen-242. Trans. N. Y. Acad. Sci.; 32: 428-40(Apr 1970).

Preliminary work showed that when blood of normal sheep was replaced with blood from γ irradiated donors, the recipient sheep withstood the treatment without apparent difficulty. No decrease in leukocytes in the recipient's circulating blood was evident. The experiments described were designed to determine the leukocyte pattern of normal animals from which the blood was removed and then replaced by blood deprived of leukocytes obtained from irradiated donors. Adequate controls were required to learn whether the effects of the exsanguinotransfusion (ET) on peripheral blood leukocytes of the recipient animal could be ascribed either to some action of the radiation on the blood of the donors, or just to the lack of leukocytes in that blood. An answer to this question was attempted by including in the study animals that received blood with a low-leukocyte count obtained by means other than irradiation. Also, for comparison, normal sheep whose blood has been replaced by that of normal donors were used; 58 normal sheep were utilized. The total number of donor and recipient sheep in these experiments was 211. (auth)

48448 BONE MARROW CHANGES FOLLOWING BLOOD REPLACEMENT FROM IRRADIATED DONORS. Souto, Jose; Anderson, Donald L. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-Gen-242. Trans. N. Y. Acad. Sci.; 32: 441-7 (Apr 1970).

Following exsanguinotransfusion (ET), cell distribution in the bone marrow of sheep having their blood replaced by that from lethally γ irradiated donors showed: a decrease in the number of immature myeloid elements, an increase in the number of immature erythroid cells; and a decrease of the immature myeloid/erythroblast ratio. An increase of each type of immature myeloid cell and a concomitant decrease in the relative number of mature granulocytes were observed immediately and 24 hours after ET completion in the bone marrow of sheep whose blood had been replaced by the blood of normal sheep donors. No differences in the cell morphology or in the cell distribution in lymph nodes were found. (auth)

48449 LOCAL REACTIONS TRANSPLANT AGAINST HOST IN IRRADIATED AND INTACT DOGS. Shereshkov, S. I.

Probl. Gematol. Pereliv. Krovi; 15: No. 7, 22-7(Jul 1970). (In Russian).

Transfer reactions of nonimmune lymphocytes (NLT reaction) in dogs were studied. Possible mechanisms of development of NLT reactions in dogs and the expediency of application of this test for choosing a donor for transplantation of organs and tissues are discussed. (auth)

48450 AUTOIMMUNIZATION WITH IRRADIATED TUMOR CELLS IN HUMAN MALIGNANT MELANOMA. Ikonopisov, R. L. (Oncological Research Inst., Sofia); Lewis, M. G.; Hunter-Craig, I. D.; Bodenham, D. C.; Phillips, T. M.; Cooling, C. L.; Proctor, J.; Fairley, G. Hamilton; Alexander, P. Brit. Med. J.; 2: 752-4 (27 Jun 1970).

Thirteen patients were immunized with their own irradiated melanoma cells on one or more occasions. Following these autografts tumor-specific cytotoxic antibodies were produced, the longest response lasting 14 days. This procedure had no apparent effect on the course of the disease in these patients. (auth) (UK)

48451 A COMPARISON OF THE IMMUNOLOGIC FUNCTION OF THYMUS CELLS AT VARYING STAGES OF MATURATION. MacGillivray, Margaret H.; Mayhew, Barbara; Rose, Noel R. (State Univ. of New York, Buffalo). Proc. Soc. Exp. Biol. Med.; 133: 688-92(Feb 1970).

Injections of mouse thymus cells from fetal, neonatal, 4-week- and 1-year-old syngeneic donors were compared for their ability to potentiate the production of serum antibody to sheep red blood cells in thymectomized, irradiated recipients previously injected with syngeneic bone marrow. Five million fetal thymus cells afforded no restoration of the immunologic response and one-year-old thymus cells gave marginal improvement. The apparent deficiency of the fetal thymus cell inoculum was quantitative since 20 million of these cells proved to be as active as five million neonatal thymus cells. Neonatal and 4-week-old thymus cells induced significant and virtually equal immunologic reactivity in terms of serum antibody titers. Immunologic restoration estimated by the number of spleen direct PFC was insignificant in all the groups given thymus cells. There was no increase in the number of indirect PFC observed in the experimental groups except for the one treated with 4-week-old thymus cells and here the restoration was significant but incomplete. These findings are discussed with reference to the cellular changes in the thymus in the perinatal period. (auth)

48452 IMMUNOLOGIC STATUS OF HOST AND RESPONSE OF A METHYLCHOLANTHRENE-INDUCED SARCOMA TO LOCAL X-IRRADIATION. Suit, Herman D.; Kastelan, Andrija (Univ. of Texas, Houston). Cancer; 26: 232-8(Jul 1970).

A methylcholanthrene-induced fibrosarcoma of C_3H/He mice has been submitted to a series of TD_{50} and TCD_{50} assays. TD_{50} is number of cells to transplant tumor into half of the recipients; TCD_{50} is radiation dose which yields control of half of the irradiated tumors. The TD_{50} was greater by a factor of 100 for transplantation into actively immunized mice instead of 400 rads whole body irradiated animals (24 hours earlier). The TCD_{50} values were 4,300 rads, 3,500 rads, and 2,700 rads for tumors transplanted into immunologically depressed mice, normal mice, and actively immunized mice, respectively. This difference in TCD_{50} would correspond to a killing by radiation dose of 100 times fewer cells in the actively immunized mice than in 400 rads' irradiated mice. There was no effect of the radiation-induced changes in normal tissue to block the efficacy of the immune rejection response to increase TD_{50}. Finally, attempts to enhance the immunologic rejection response being mounted by a normal mouse against an established tumor were not successful. (auth)

Ecology

Refer also to abstracts 48377, 48475, 48572, and 48738.

48453 (BMI-171-37) DARIEN PHYTOSOCIOLOGICAL DICTIONARY. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic-Pacific Interoceanic Canal. Duke, James A. (Battelle Memorial Inst., Columbus, Ohio); Porter, Duncan M. (Missouri Botanical Garden, St. Louis). 1 Jun 1970. Contract AT(26-1)-171. 70p. Dep. CFSTI.

Vegetation types found along the proposed canal routes in Panama are listed and described and pertinent observations on Panama vegetation types are included. Tables are presented to show relationships between the forest types of Darien, key to Darien forest types, zonal vegetation types along potential canal routes, and attributes of some Darien localities. An appendix is included in which approximately 1200 species of seed plants are listed taxonomically and classified according to forest type. (H.L.W.)

48454 (BMI-171-41) BIBLIOGRAPHY. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic-Pacific Interoceanic Canal. Rudolph, A. W.; Carroll, T. E.; Davidson, R. S.; Waller, A. E. (comps.) (Battelle Memorial Inst., Columbus, Ohio). 30 Jun 1970. Contract AT(26-1)-171. 231p. Dep. CFSTI.

A compilation of approximately five thousand computer-printed abstracts and bibliographic citations was prepared in support of research programs on feasibility studies and possible effects of a sea-level canal on the marine ecology of the Isthmian region. Some of the major topics included are human, agricultural, forest, freshwater, and marine ecology, and hydrological and ecological transfer processes. A coordinate index and thesaurus were prepared to accompany this bibliography. (H.L.W.)

48455 (BMI-171-43) BIOENVIRONMENTAL AND RADIOLOGICAL-SAFETY FEASIBILITY STUDIES, ATLANTIC-PACIFIC INTEROCEANIC CANAL: INDEX. Rudolph, A. W.; Carroll, T. E.; Davidson, R. S.; Waller, A. E. (comps.) (Battelle Memorial Inst., Columbus, Ohio). 30 Jun 1970. Contract AT(26-1)-171. 269p.

The index to the bibliography is divided into three sections: technical subject; author, organization; and bibliographic source. Within each section the index terms are arranged alphabetically, and the accession numbers of all abstracts indexed by a particular term are posted by the computer in the terminal digit order. (H.L.W.)

48456 (BNWL-1307(Pt.2)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1969 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME II. PHYSICAL SCIENCES. PART 2. RADIOLOGICAL SCIENCES. Nielsen, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT(45-1)-1830. 72p. Dep. CFSTI.

Fourteen sections are included; an abstract was prepared for each. (P.C.H.)

For abstracts of individual sections see: 48047, 48048, 48106, 48178, 48179, 48193 48300, 48457-48459, 48536, 48537, 48600, and 49014.

48457 (BNWL-1307(Pt.2), pp 5-7) RATES OF DEPOSITION OF AIRBORNE RADIONUCLIDES IN THE ALASKAN ENVIRONMENT. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

The atmospheric deposition rates, routes, biological uptake rates, and concentrations of fallout radionuclides and their stable element counterparts are being investigated in the terrestrial and marine environments, with emphasis on the food chains that consistently lead to high radionuclide concentrations. (auth)

48458 (BNWL-1307(Pt.2), pp 28-30) ^{55}Fe IN THE HUMAN POPULATION OF THE WORLD. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

This study investigates the transfer of ^{55}Fe from fallout, with special emphasis on the concentrations in man and in food chains leading to human consumption. Transfer is being measured in the general population as a function of age, sex, and diet, including the dilution effect of stable iron. Although ^{55}Fe is being emphasized, some of the same samples are used to measure Pb, ^{210}Pb, and ^{210}Po in the biosphere. (auth)

48459 (BNWL-1307(Pt.2), pp 40-2) INTERNAL DEPOSITIONS OF RADIONUCLIDES IN MAN. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

These studies are concerned with the continued development and improvement of diagnostic techniques for the assessment of internal depositions of radiotoxic materials in man. The studies are restricted primarily to investigation of radionuclides of interest to the nuclear industry that are difficult or impossible to reliably assess in vivo through the use of external radiation detectors such as whole-body counters. Because of this restriction, analysis of body excretion is the usual method of diagnosis, quantification of which is accomplished through excretion studies on human test subjects. Since the radionuclides of interest are usually highly radiotoxic, substitute isotopes that have good measurement sensitivity but which are much less radiotoxic are developed for use in human testing studies. Animal studies performed to give basis for human studies also permit correlation of metabolic parameters between man and animals that in turn can give basis to other animal studies. (auth)

48460 (CEA-CONF-1550) ATMOSPHERIC ^{85}Kr NUISANCE. Pannetier, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 39p. (In French). (CONF-700505-8). Dep. CFSTI (U. S. Sales Only).

From 2nd Congress of the International Radiation Protection Association, Brighton, England.

The world distribution of ^{85}Kr is found to be uniform in the atmosphere (i.e., $5.1 \cdot 10^{18}$ kg). The amount of krypton dissolved in the world water being 2% of the amount of atmospheric krypton and the isotope ^{85}Kr being at a lower isotopic concentration, the amount of ^{85}Kr dissolved in water is found to be negligible. A M. P. C. equal to 3.10^{-4} μCi/g of ^{85}Kr is selected for workers. The curve representing the variation of krypton specific radioactivity in France from 1954 until now indicates a multiplication by ten during the first nine years. The multiplication by ten necessitates 13 or 14 years since 1963. The total amount of atmospheric ^{85}Kr may be estimated by means of the contribution of the nuclear explosions and that of the nuclear power plants. The world production of ^{239}Pu is found to be about one hundred tons. The contribution of power plants should increase from $\frac{1}{3}$ to $\frac{2}{3}$ of the total contamination in 1980 and should represent the total contamination in the year 2000. The "engaged dose" notion is used in order to evaluate the consequences of ^{85}Kr atmospheric disposal. The storage of ^{85}Kr and radioactive gaseous effluents by underground disposal constitutes a satisfactory solution. (auth) (France)

48461 (CEA-CONF-1552) EVALUATION OF INTERNAL IRRADIATION DOSES FROM INGESTION BY HUMAN POPULATION OF FOOD CONTAMINATED BY ^{90}Sr AND ^{137}Cs WITH THE VIEW OF DETERMINATION OF RADIONUCLIDE DISPOSAL LEVELS INTO THE ENVIRONMENT. Garnier, Arlette (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 26p. (In French). (CONF-700505-5). Dep. CFSTI (U. S. Sales Only).

From 2nd Congress of the International Radiation Protection Association, Brighton, England.

Models for the determination of the disposal levels of radioactive materials into the environment were investigated. Average doses of internal irradiation from ingestion of food contaminated by ^{90}Sr and ^{137}Cs were evaluated. The effects of conditions and mechanisms of transfer from the environment, the various food vectors, and the characteristics of human populations concerned (age, diet, and anatomical and physiological parameters) were studied. The parameters introduced in the models were selected, either from bibliographical surveys or from experiments and investigations. The effects of the type of diet and of the radionuclide uptake and elimination in relation with that of the age of the subjects under internal contamination were investigated. (auth) (France)

48462 (CEA-CONF-1560) EFFECTS ON HEALTH OF ATMOSPHERIC DISCHARGES OF TRITIATED STEAM. Planet, Jacques; Uzzan, Guy; Le Grand, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 23p. (In French). (CONF-700505-11). Dep. CFSTI (U. S. Sales Only).

From 2nd Congress of the International Radiation Protection Association, Brighton, England.

A general method of evaluating the irradiation of man is first described and then applied to the case of a given site. The dispersion of tritiated water in the physical environment (dispersion in air, rainwater contamination, and ground contamination), the contamination of plant and animal foodstuffs, and finally the irradiation of man are examined. The dose corresponding to a yearly exposure in a contaminated atmosphere and the variation in this dose as a function of the age of individuals are estimated. The dose absorbed by ingestion of tritiated water vapor is also studied. This method is applied to a plant, 3 km distant from a village, discharging tritiated steam continuously through a chimney. (auth) (France)

48463 (LA-3639) LOS ALAMOS ENVIRONMENTAL MONITORING PROGRAM. Kennedy, William R. (Los Alamos Scientific Lab., N. Mex.). Jan 1970. Contract W-7405-eng-36. 11p. Dep. CFSTI.

The Los Alamos Scientific Laboratory complex includes accelerators, research reactors, radioactive materials separation facilities, and other experimental installations using radiation or radioactive materials. In operation of the Laboratory, certain radioactive wastes are generated and must be disposed of. An outline is given of the surveillance methods used throughout Los Alamos County and outside restricted areas to determine the effect of Laboratory operations on the environmental radioactivity. Gamma radiation measurements are routinely made. Scheduled samples of air and water are taken, assayed for gross alpha and beta activity, and also for certain specific nuclides which may be present in some concentration. Soil samples are taken when considered necessary. (auth)

48464 (NP-18395) STUDY OF MANGANESE CYCLE IN FRESH WATERS AND BRINE USING ^{54}Mn. Asselin-Bagarry, D. (Aix-Marseilles Univ. (France). Faculte des Sciences). Jun 1970. 199p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The experimental material is first described (manganese, carp, Cyprinus carpio, aquatic plants Potamogeton densus and P. natans, amphipod crustaceans Gammarus pulex) and the experimental methods are given. Dynamics of ^{54}Mn with the sediment were studied in fresh water and brine. Potamogeton densus (L) and Potamogeton natans (L) show a maximum absorption of ^{54}Mn within 10 days followed by an accumulation level, their concentration factor lying between 30,000 and 80,000. Living Gammarus pulex (L) absorb about 4% of the ^{54}Mn found in the plants upon which they live. The distribution of ^{54}Mn in a small ecosystem in equilibrium for 3 years was determined. Spectrometric study of ^{54}Mn absorption and desorption by the living fish was investigated as a function of time and experimental methods. Dynamics of absorption and desorption of ^{54}Mn from fresh water and from food by the various tissues and organs of the fish, Cyprinus carpio (L), were investigated. The accumulation level was reached in 9 days in fresh water and in 13 days in brine. The slow desorption phase is 47 days in fresh water, while it is 63 days in brine. The critical organ is the intestine; it contains 36.8% of the whole activity in fish. (France)

48465 (NP-18401) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND MEASUREMENTS ON SAMPLES FROM FIJI AND RAROTONGA, Annual Summary, 1969. (National Radiation Lab., Christchurch (New Zealand)). 33p. (NRL-F-38). Dep. CFSTI (U. S. Sales Only).

Data are presented on levels of environmental radioactivity at selected sites in New Zealand during 1969. Results are presented from measurements of total β activity from short-lived fission products, attributed to the 1967, 1968, and 1969 French bomb tests, in air filter and rainwater samples and measurements of the content of ^{137}Cs and ^{90}Sr, attributed to delayed stratospheric fallout, in samples of milk. Measurements were also made on the content of ^{89}Sr and ^{90}Sr in samples of rainwater, ^{90}Sr in samples of soil, ^{210}Pb in samples of rainwater, ^{222}Rn in ground water, and ^{90}Sr, ^{226}Ra, and ^{210}Pb in samples of human bones. (C.H.)

48466 (NYO-3974-2) CYCLING AND EFFECTS OF ^{36}Cl LABELED DDT ON SOIL INVERTEBRATES. Annual Progress Report. Dindal, Daniel L. (State Univ. of New York, Syracuse. Coll. of Forestry). [1969]. Contract AT(30-1)-3974. 13p. Dep. CFSTI.

Investigations were conducted on cycling of ^{36}Cl-labeled DDT residues, the possibility of storage equilibrium, and the magnification of residues in soil microcommunities; alterations in the invertebrate food-web relationships in litter and soil of an old field herbaceous community; content of DDT residues and metabolites in soil invertebrates; qualitative and quantitative population density changes in invertebrate fauna of litter and soil resulting from the application of technical DDT; and determination of time-related changes in invertebrates over a three-year period after insecticide application. (H.L.W.)

48467 (SWRHL-102-r) ANIMAL INVESTIGATION PROGRAM, 1969 Annual Report. Smith, D. D.; Giles, K. R. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Aug 1970. 27p. Dep. CFSTI.

The radionuclide contents of selected bovine, deer, and Bighorn sheep tissues which were collected during 1969 from animals grazing on or near the Nevada Test Site are reported. The radionuclide burden remains low, with the highest levels and widest range reported from animals collected in May. The strontium content of bones collected from all three species continues the downward trend of recent years. Other activities of the Animal Investigation Program during 1969 are also mentioned. Tables are presented to show contents of ^{144}Ce, ^{137}Cs, ^{131}I, ^{40}K, ^{54}Mn, ^{106}Ru, ^{89}Sr, and ^{90}Sr. (auth)

48468 (SZS-7/70) ACCUMULATION OF RADIONUCLIDES IN FISH. Ettenhuber, E. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Apr 1970. 30p. (In German). Dep. CFSTI (U. S. Sales Only).

A review is given on investigations of the accumulation of radionuclides by fishes with consideration of radiation protection implications. Biochemical and physiological relationships, especially the relationship between the accumulation factors and environmen-

tal parameters are discussed only as far as they are necessary to evaluate the compiled factors. A tabular compilation is given of accumulation factors for different species of fishes and a number of radionuclides. (auth)

48469 (SZS-11/70) CONFERENCE OF THE GERMAN-POLISH WORK GROUP FOR THE SURVEILLANCE OF THE RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT, BERLIN, JUNE 16-21, 1969. PART II, 2. Moldenhawer, F.; Bose, H.; Korsetz, B. (comps.) (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). May 1970. 30p. (In German). Dep. CFSTI (U. S. Sales Only).

From 1963 to 1968, levels of ^{90}Sr and ^{137}Cs content of foodstuff are reported for the DDR. Results are presented in seven tables and three graphs. From a maximum reached in 1963 and 1964, radioactivity showed a gradual decline. Principles of monitoring air, soil, and foodstuff for fallout contamination are presented. Following a nuclear explosion, radioisotopes reached maximal amounts in air: 2 to 3 weeks, in precipitation: 3 to 30 weeks, in man: 2 to 3 years, in soil: 3 to 4 years. Monitoring programs are outlined for atmosphere surface water, soil and vegetation, foodstuff, and imports. (H.B.G.)

48470 UPTAKE, RETENTION, AND DISTRIBUTION OF ^{60}Co, ^{65}Zn, ^{85}Sr, AND ^{131}I IN THE ROUGH-SKINNED NEWT (TARICHA GRANULOSA): A RADIOECOLOGICAL STUDY. Valett, Bryan Batson. Corvallis, Oreg.; Oregon State Univ. (1970). 110p. Thesis.

The uptake, retention, and distribution of ^{60}Co, ^{65}Zn, ^{85}Sr, and ^{131}I were examined in the rough-skinned Newt (Taricha granulosa). The newts were maintained singly at 10°C in an unfed condition. An armac liquid scintillation detector was used for determination of whole-body radioactivity and tissue samples were assayed in a 3" × 3" NaI(Tl) well crystal. The counting error did not exceed the 1% level. The uptake of ^{60}Co, ^{65}Zn, and ^{85}Sr from water and whole-body retention after this chronic exposure was compared to retention patterns obtained after a single injection (I.P.). These retention curves showed two components, a short-lived component and a long term component. The biological half-lives of the long term components after chronic and acute administration were 127 and 114 days for ^{60}Co, 1233 and 1260 days for ^{65}Zn, and 136 and 131 days for ^{85}Sr, respectively. The whole-body retention of ^{131}I was followed after acute administration only. A two component curve was seen with the fast component having a biological half-life of 2.05 days and containing 74% of the initial dose. The long term component had a biological half-life of 210 days. Effective half-lives for the long term components of the ^{60}Co, ^{65}Zn, ^{85}Sr, and ^{131}I retention curves were calculated using the above biological half-lives. The pattern of distribution of the four radionuclides in the tissues of the newt was determined over a 100 day period for ^{60}Co, ^{65}Zn, and ^{85}Sr, but only over 27 days for ^{131}I. Fourteen tissues were assayed for activity after a single injection (I.P.). They included blood, skin, thyroid, spleen, liver, stomach, intestine, lung, heart, testes, kidneys, bone, eyes, and muscle. The kidneys accumulated the major concentration of ^{60}Co and the eyes concentrated radiozinc to a greater extent than the other tissues. Bone was the site of the highest concentration of ^{85}Sr, while the thyroid concentrated ^{131}I more than all other tissues combined. With the exception of ^{131}I, the relatively long effective half-lives indicated that the radioactivity would be found in an exposed amphibian population for a considerable time period. Predators of these amphibians could then acquire radioactivity long after the original contamination of the freshwater system. Radioiodine, due to its short effective half-life, would become a hazard only in areas of excessive contamination or where a short food chain is involved. (Diss. Abstr.)

48471 ^{90}Sr AND ^{137}Cs CONTAMINATION OF PLANTS AND SOILS ON THE TERRITORY OF THE GERMAN DEMOCRATIC REPUBLIC DURING 1966 TO 1968. PART II. Bose, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie; 13: 156-62(May 1970). (In German).

^{90}Sr soil contamination had its maximum (37 nCi/m^2) in 1966 and was regressive in the following years of examination (1968: 28 nCi/m^2). Highest ^{90}Sr concentration was recorded in the soil layers of activity profiles routinely examined (0 up to 15 cm). ^{90}Sr contamination of plants was approximately equivalent to ^{90}Sr fallout activity. Dry matter ^{90}Sr content of the plant parts above ground decreased in 1966 and 1967 with respect to the preceding year. It did not change in 1968 as compared with 1967 in spite of the low increase of fallout in the vegetational periods of 1968. The differences of ^{90}Sr total contamination of the various plants became smaller. In part, ^{137}Cs contamination of the plant materials examined showed greater regression than ^{90}Sr. The $^{137}Cs/^{90}Sr$ ratio was approximately constant in grass, cabbages, and potato herb. ^{90}Sr surface contamination evaluations did not indicate the decrease to be expected in 1967, the test year of lowest ^{90}Sr fallout activity in the growing seasons. The minimum of ^{90}Sr fallout retention of the plant surfaces was in 1968 (8 up to 26 percent). Evaluations of the OR values and of the portions of ^{90}Sr deposited in the ground, that were taken up by the plants, did not essentially change with respect to the preceding test period. (auth)

48472 REPRODUCTIVE DYNAMICS OF A TURTLE (PSEUDEMYS SCRIPTA) POPULATION IN A RESERVOIR RECEIVING HEATED EFFLUENT FROM A NUCLEAR REACTOR. Gibbons, J. W. (Savannah River Ecology Lab., Aiken, S. C.). Can. J. Zool.; 48: 881-5(Jul 1970).

Individual yellow-bellied turtles (Pseudemys scripta) in Par Pond, a thermally polluted reservoir on the Savannah River Plant, Aiken, South Carolina, U.S.A., reach exceedingly large body sizes and maintain extraordinary juvenile growth rates when compared with turtles of this species from other populations in the vicinity. Increased water temperatures are not directly responsible for the observed size and growth differences. Diet differences resulting from increased productivity at lower trophic levels as a result of the hot-water effluent may be the cause of the observed growth and size phenomena. The increased growth rates and larger body sizes in the Par Pond turtles result in changes in reproductive rate which may have interesting consequences on the demography of the population. (auth) (Canada)

48473 HEALTH OF WORKERS IN THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY. Duncan, K. P.; Howell, R. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys.; 19: 285-91(Aug 1970).

Detailed statistics of the morbidity and mortality experience of workers employed by the United Kingdom Atomic Energy Authority have been maintained for some years. A summary of the data for the years 1962-1968 is presented. No evidence of job related illness is revealed and the social and other factors influencing the variation in absence from work attributed to sickness are discussed. (auth) (UK)

48474 NATURALLY OCCURRING CONCENTRATIONS OF ALPHA-EMITTING ISOTOPES IN A NEW ENGLAND POPULATION. Hunt, Vilma R.; Radford, Edward P. Jr.; Segall, Ascher (Harvard School of Public Health, Boston). Health Phys.; 19: 235-43(Aug 1970).

Concentrations of polonium-210, radium-226 and radium-224 were measured radiochemically in extracted teeth obtained from a population in New Hampshire and Vermont, U.S.A. Polonium-210 is indicative of the concentration of lead-210 and radium-224 is taken to be a measure of radium-228. Mean values in teeth were found to be 0.059 pCi/g ash (N = 219) for lead 210, 0.016 pCi/g ash (N = 218) for radium-226 and 0.008 pCi/g ash (N = 55) for radium-228. Differences in the radiogeological character of the two states were not markedly reflected in the skeletal concentrations of the radioelements in the population studied. Only radium-226 was significantly higher in the New Hampshire population. However, there was considerable variability for each of the three radioelements measured in the total sample and skeletal levels of lead-210 in males were significantly higher than those found in females. An estimate of the skeletal dose delivered by the alpha-emitting isotopes and their daughters to bone marrow and osteocytes has been made and polonium-210, the daughter of lead-210, was found to be the major background source of alpha radiation. (auth) (UK)

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Refer also to abstracts 48382, 48414, 48440, 48669, 48738, 48748, 48757, and 48777.

48475 (AD-702029) STRONTIUM METABOLISM WITH SPECIAL CONSIDERATION OF GENETIC EFFECTS. Final Report, September-October 1969. Crissman, John D.; Kirk, John H. (School of Aerospace Medicine, Brooks AFB, Tex.). Jan 1970. 28p. (SAM-TR-70-3; SAM-Review-1-70). CFSTI.

Strontium metabolism is reviewed to determine possible correlations between ^{90}Sr fallout and decreased decline in infant mortality rates. Strontium fallout characteristics, metabolism and reproductive tract kinetics are discussed. Articles making positive correlations between ^{90}Sr fallout and the apparent decrease in expected continued decline in infant mortality rates are present. Strontium-90 was found to be capable of producing lethality and genetic mutations. The significances of strontium, however, as the sole or predominant influence on infant mortality is questioned due to lack of knowledge concerning strontium reproductive kinetics and absence of studies with parameters such as magnitude of dose

and route of administration that are comparable to those produced at current fallout levels. (auth)

48476 (ORNL-tr-2332) STUDY OF CHROMOSOMAL ABERRATIONS IN PERSONS EXPOSED TO REPEATED OCCUPATIONAL IRRADIATION. Sevan'kaev, A. V.; Bykhovkii, A. V.; Bochkov, N. P. Translated for Oak Ridge National Lab., Tenn., from Genetika; 5: No. 7, 126-8(1969). 5p. Dep. CFSTI.

Chromosome aberrations were studied in a culture of peripheral blood leukocytes taken from 12 men subjected to repeated professional gamma irradiation during periods of time varying from 2 months to 4 years. The total cumulative doses received by these men during these periods varied from 0.02 to 2.08 R. The frequency of chromosomal aberrations in this group was shown to be 3 to 4 times as high as that in the control group consisting of 7 men of the same age. The frequency of aneuploid cells was also higher than in the control group. The determination of the chromosome aberrations in the cultures of peripheral blood leukocytes is recommended as a method of detection of the early symptoms of the effect on the organism of low radiation levels associated with the profession of the persons affected and with roentgeno-radiological medical procedures. (auth)

48477 (ORO-1747-16) RADIATION GENETICS AND RADIATION RESISTANCE IN PEANUTS. Progress Report, July 1, 1969-June 30, 1970. (North Carolina State Univ., Raleigh). Contract AT(40-1)-1747. 44p. Dep. CFSTI.

It seemed reasonable to assume that drastically altered peanut macro-mutants would have differential responses to environments known to be optimal for the control line. Furthermore, since these particular mutants had not been grown at temperatures other than that optimal for the control, a new order of selection potential might develop when the range of temperature environments is expanded. Seven macro-mutants derived from an x radiation induced mutant of an inbred line of plants and the unirradiated autogamous mother line were grown as seedlings at four different controlled temperatures. The macro-mutants were found to respond differently to a range of day temperatures between 22° and 34°C. The characters dry weight and content of N, P, K, and Ca were selected as examples to demonstrate the mutant by temperature interactions. Leaflet expressions were also recognized as a means of displaying interactions. Since both dry weight and nutrient content conceivably could be correlated with fruit yield, selection potential for yield may be altered with changes of temperature. High numbers of flowers, a likely prerequisite for high yield, was also found to vary with the mutant and the temperature. Thus one temperature might be used to select maximum flowering in one mutant and another temperature for other mutants. (C.H.)

48478 (SAN-590-6) X-RAY INDUCED CHANGES IN DROSOPHILA GERM CELLS. A Three-Year Comprehensive Report, September 1, 1967-August 31, 1970. Rinehart, Robert R. (San Diego State Coll., Calif.). Contract AT(04-3)-590. 28p. Dep. CFSTI.

Female Drosophila melanogaster were inseminated and exposed to 4000 R x radiation delivered within a few seconds, a few minutes, a few hours, or two weeks. A sample of sperm, exposed to the radiation in the female, was tested for sex-linked recessive lethality. The females were brooded for 14 days so all postoogonial cells, at the time of irradiation, were eliminated. A sample of female X-chromosomes was tested then for X-linked recessive lethality. No consistent differences among sex-linked recessive lethal frequencies of sperm given 4000 R at 9 to 240,000 R/hour rates were observed. There was a consistent trend of increasing recessive lethal frequencies with increasing exposure rates when oogonia were considered, and a consistent decrease in the ratio of percent lethality of sperm to percent lethality of oogonia with increasing exposure rate. When Drosophila melanogaster females with attached X-chromosomes were x irradiated and mated to appropriate males, it was possible to detect phenotypically chromatid interchanges that had been induced in germ cells. Both the relative frequency of interchange and the chromosomes involved were determined. The results of the first generation of selection showed an increase in x-ray induced interchanges per female, an increase in total aberrations, a decrease in total offspring per female produced, and an increase in either induced or spontaneous nondisjunction. (C.H.)

48479 (UCSF-10-P-2-110) CHROMOSOME ABERRATIONS: MECHANISMS OF CELL DEATH. Wolff, Sheldon (California Univ., San Francisco). [1970]. 10p. (CONF-700610-8). Dep. CFSTI.

From 4th International Congress of Radiation Research, Evian, France.

A review of the literature on chromosome abnormalities with relation to cell death is presented. It is quite clear that low doses of ionizing radiation kill cells by damaging the genetic apparatus within the nucleus. Of the three types of damage that could possibly be induced, i.e., effects on replication, mutation, and chromosome aberrations, correlations between the amount of damage and the dose of radiation show that only chromosome aberrations can account for the majority of cell death. Although it is commonly stated that the sensitive target is DNA, as yet there is no clear picture as to how such damage could induce chromosome aberrations and it would be more accurate to state that cell killing is caused by a genetic effect, an effect on the nucleus, or an effect on chromosome aberration induction. In all three cases a change in the amount or arrangement of the DNA would still be responsible for the final effect. (auth)

48480 BETA-INDUCED CHROMOSOME BREAKAGE PHENOMENA IN PLANTS. Dasgupta, P. (Bose Research Inst., Calcutta). Cytologia (Tokyo) 35: No. 1, 1-12(Mar 1970).

After treatment of two varieties of Brassica campestris L. (2n = 20), T10 and T151, with radioactive chemicals ^{32}P and ^{35}S, of different concentrations, aberrant cells were scored in meiosis for studying the radiation effects. According to the nature of abnormalities in metaphase and early anaphase, cytological effects and the origin of different abnormal configurations were explained. Significance of probability of the nature of abnormalities was estimated by the X^2 test and aberration rates were statistically estimated. Sampling error was also calculated per treatment in percent to record the optimum sample size for analysis. A linear relationship between treatments and cytological aberrations was shown. (auth) (Japan)

48481 MODIFICATION OF THE INJURING EFFECT OF FAST NEUTRONS ON WINTER RYE CHROMOSOMES. Pomogaibo, V. M. Tsitol. Genet.; 3: 243-6(1969). (In Russian).

The results are presented of experiments on modification of the fast neutron effect on winter rye chromosomes. The observations were made on the percentage and character of the chromosomal aberrations in the first mitosis of the seedlings. The results showed that a post-irradiation storage of seeds at indoor temperature, change of moisture content, and post-irradiation heat-shock treatment modify the cytogenetic effect of fast neutrons on chromosomes quite clearly. The mechanism of development and display of the injuring effect of fast neutrons on chromosomes is partially of a biochemical nature. (auth)

48482 RADIATION ANALYSIS OF A COMSTOCKIELLA CHROMOSOME SYSTEM (HOMOPTERA:COCCOIDEA). Kitchin, Robert Michael. Berkeley, Calif.; Univ. of California (1969). 130p.

Thesis.

In Parlatoria oleae (Colvée), characterized by a Comstockiella system, both males and females begin development as diploids, but during late cleavage or early blastula one set of chromosomes becomes heterochromatic in the males, and remains heterochromatic in most tissues throughout development. Immediately before the onset of meiosis one or more heterochromatic chromosomes disappear from each primary spermatocyte. At prophase and metaphase, four euchromatic and from one to three heterochromatic chromosomes were present in each cell. The disappearance of the heterochromatic chromosomes before meiosis could be explained as due either to the deheterochromatization of the heterochromatic chromosomes and their subsequent pairing with their euchromatic homologues, or to the destruction of the heterochromatic chromosomes. Genetic markers were created through maternal or paternal x irradiation. Chromosome aberrations were induced in the heterochromatic set of male embryos after paternal x-ray treatment; after maternal treatment, the aberrations were induced in the euchromatic set. Lethality in the X_1 males was very low after the moderate paternal x-ray doses used in these experiments. When administered to the mother, similar x-ray doses almost always resulted in lethality in the X_1 male embryos. It is concluded that the heterochromatic set in the males is of paternal origin and is genetically inactive. The alternative interpretations of spermatogenesis in P. oleae, chromosome pairing vs chromosome destruction, were directly tested by using chromosome aberrations, that were induced in the heterochromatic set by paternal irradiation, as genetic markers in breeding tests of approximately 400 X_1 males. Spermatogenesis was examined in X_1 males that showed unusually long chromosomes in their somatic cells. The absence of either heteromorphic chromosome pairs or multivalents at spermatogenesis and the failure of the X_1 males to transmit any form of chromosome aberration induced by paternal irradiation is strong evidence that the heterochromatic chromosomes are destroyed in P. oleae. The evolutionary relations of the lecanoid, Comstockiella, and diaspidid systems are considered. Models are outlined for the derivation of a Comstockiella system involving chromosome destruction either from a lecanoid system

or from a hypothetical Comstockiella system involving chromosome pairing. Problems concerning the control of chromosome destruction are discussed. (Diss. Abstr. Int., B)

48483 GENETIC STUDY OF NECROTIC LEAF SPOT MUTATION INDUCED IN AN INBRED LINE OF MAIZE (ZEA MAYS L.) BY THERMAL NEUTRON IRRADIATION OF SEED. Hornbrook, A. R.; Gardner, C. O. (Univ. of Nebraska, Lincoln). Radiat. Bot.; 10: 113-17(Apr 1970). (COO-1512-15).

Thermal-neutron irradiation of maize seeds produced a subline of N25 inbred that developed necrotic leaf-spots just prior to tasseling time. Genetic studies clearly indicate that the trait is controlled by a pair of alleles with the normal allele being completely dominant over the necrotic leaf-spot allele. In homozygous recessive plants, degree of spotting varied from leaf to leaf, but symptoms were always present with one exception, which conceivably could have been an outcross. The mutant line yields 18.7% less grain than the normal, but the heterozygote exhibited a surprising amount of heterosis, outyielding the two-parent mean by 18.6% and the normal parent by 7.5%. The latter was not statistically significant, however. In population studies, genes such as this contribute an important amount of genetic variability in some quantitative traits. The chromosome on which the gene is located has not yet been established. (auth) (UK)

48484 BONE MARROW TRANSPLANTATION IN IRRADIATED MONKEYS: CHROMOSOME ABERRATIONS IN DONOR CELLS. Udalov, G. A.; Chertkov, J. L. (Central Inst. of Haematology and Blood Transfusion, Moscow). Nature (London); 226: 956-8(6 Jun 1970).

It is stated that serious chromosome injuries, of a type not previously reported, were found unexpectedly in many donor cells during studies of bone marrow repopulation after transplantation to irradiated monkeys. The studies described were made on baboons and rhesus monkeys exposed to ^{60}Co γ irradiation at doses of 800 to 1,500 R at a dose rate of 50 to 200 R/min, followed by doses of autologous or allogeneic bone marrow 1.5 to 2 hr after irradiation. In the first 2 to 4 days after irradiation, only considerably injured cells with numerous chromatid breaks and translocations were found in the monkeys, and severe chromosome fragmentation was frequent. Active repopulation by the transplant occurred during the second week; together with a few considerably injured cells, a large number of uninjured metaphases belonging to the bone marrow donor were found, some of which had definite structural chromosomal abnormalities; the monkeys showed chromosome aberrations in 7 to 30% of bone marrow donor cells. Chromatid and isochromatid breaks were almost equal in frequency, but translocations were much rarer. An increase in the number of cells with gaps was also revealed among cells undergoing repopulation. By the end of the third post-irradiation week the number of injured cells was reduced. The chromosome injuries were not self-reproducing and were lost at the first mitosis. It is concluded that factors that can cause chromosome aberrations in the proliferating haemopoietic cells exist during the first weeks after irradiation, and it seems possible that injuries to donor cells may be caused by a virus infection, which frequently develops in monkeys suffering the severest form of acute radiation sickness. The results should be taken into account in radiobiological studies; they suggest that not every cell with chromosome aberrations found in an irradiated animal was exposed to the direct action of radiation. (UK)

48485 FACTORS DAMAGING THE EMBRYO IN THE EARLY PERIOD OF DEVELOPMENT. Maszkiewicz, Waldemar. Wiad. Lek.; 22: 1975-80(Nov 1969). (In Polish).

Development of the embryo may be interfered with by genetic factors and environmental effects. Radiation increases the frequency of mutations; it affects both the number and the structure of chromosomes. Studies indicated an increased incidence of retardation among children exposed at 1500 m to the atomic bomb in utero 15 weeks after conception from ground zero. Infection of the mother presents a serious danger. It is often difficult to separate the effect of environmental and genetic factors. (TTT)

48486 MUTATSIONNAYA SELEKTSIYA. (Selective Mutation). Zimont, S. L. (ed.). Moscow; Izdatel'stvo Nauka (1968). 311p.

Sixty articles are included on the most effective chemical mutagenic agents for various agricultural plants. Theoretical and experimental data are correlated and the influence of various chemical mutagens are evaluated. Two articles included compare the effectiveness of γ rays and chemicals for induction of selective mutations. (R.V.J.)

48487 MECHANISM OF THE RECOMBINANT INCREASE IN X-IRRADIATED BACTERIOPHAGE T4D. Campbell, Douglas Arthur. Seattle; Univ. of Washington (1969). 182p. University Microfilms Order No. 70-8442.

Thesis.

The availability of high-resolution genetic techniques has permitted a detailed examination of progeny of x-irradiated bacteriophage T4D. The principal observation is that the frequency of genetic recombination is increased among the progeny of a parental mixture irradiated before infection with 50 KeV x rays. The experimental findings and evidence to support them are presented. (Diss. Abstr.)

48488 MUTANTS OF ESCHERICHIA COLI K12 $(\lambda)^+$ NON-INDUCIBLE BY THYMINE DEPRIVATION. I. METHOD OF ISOLATION AND CLASSES OF MUTANTS OBTAINED. Devoret, Raymond; Blanco, Manuel (CNRS, Gif-sur-Yvette, France). Mol. Gen. Genet.; 107: 272-80(1970).

A selective enrichment method based upon differential killing by thymine deprivation of inducible as compared to non-inducible lysogens was employed to isolate mutants of Escherichia coli K12 $(\lambda)^+$ deficient in lysogenic induction. The efficiency of the method is such that about 1% of the surviving colonies are resistant to thymineless induction. About half of the mutants are recA recombination-deficient. Two other classes of non-inducible Rec^+ mutants can be distinguished. No temperature conditional bacterial mutations could be obtained. Our results demonstrate that deficiency in the recA gene product is not the only bacterial factor which prevents lysogenic induction. Each mutant was exposed to ultraviolet light and x radiation since recA deficient mutants display a very high sensitivity to both radiations. In addition, all of the cured mutants were infected by phage λpdbio10 which has an extremely low efficiency of plating on the recA deficient bacteria. Those which were uv-sensitive, x-ray sensitive, and did not support λpdbio growth were considered as recA recombination-deficient. (auth)

48489 CHANGES OF ANATOMICAL CHARACTERS OF FESTUCA RUBRA L., SSP. GENUINA VAR. GRANDIFLORA HACK., INDUCED BY GAMMA-RADIATION. Indruch, I. (Grassland Research Station, Roznov, Czech.). Genet. Slechteni; 6: 85-93 (May 1970). (In Czech).

In mutation breeding and other ways of grass breeding it is important to define the direction in which the new change effects. Nutritional value of grasses is represented by content of digestible organic matter or fibre. In irradiated material were found significant changes in either extreme, increase or decrease of sclerenchyma content (27.47 and 14.28%), number of trichoms per mm^2 (289 and 207), number of short epidermal cells per mm^2 (145 and 106.5) dry matter content (12.68 and 11.69%), fibre content (18.23 and 14.43%). The most expressive were changes in lignification of abaxial side sclerenchyma, which played a decisive role in fibre content. (auth)

48490 CHROMOSOME ABERRATIONS IN BONE MARROW CELLS OF MICE TREATED WITH ^{131}I OR ^{32}P DURING THEIR EMBRYONAL DEVELOPMENT. Todorov, Sv.; Baev, Il.; Ivanov, B.; Bayrakova, A. Rentgenol. Radiol.; 9: No. 1, 6-10(1970). (In Bulgarian).

Iodine-131 or ^{32}P was administered intraperitoneally to female mice on the 12th day of pregnancy. A cytogenetic study of the bone marrow cells was carried out on the male progeny that had reached the age of 9 months. Persisting chromosome aberrations were found in the animals that had been exposed to the action of the radioactive isotopes during embryonal development. These aberrations consisted of chromatid breakages with preservation or loss of the acentric fragment, chromosome breakages, and the formation of chromosome gaps. Table and figures, 26 references (1 Bulgarian, 3 USSR, 22 Western). (JPRS)

48491 STUDIES ON THE FERTILITY OF RADIOLOGISTS. Czeizel, A.; Bene, E. (National Inst. of Public Health, Budapest). J. Biosoc. Sci.; 1: 145-51(1969).

Reproductive performance and some of the more important features of their progeny were studied in 755 radiologists and in 346 laboratory technicians as controls in order to investigate the possible genetic injuriousness of ionizing radiation. Significant differences were found only in fertility: the fertility of female radiologists was significantly lower than that of the female laboratory technician and of the wives of male radiologists. This phenomenon is probably explained by a more extended use of the methods of birth control by female radiologists due to roentgenophobia. (auth)

48492 PROVOKED CHROMOSOME ANOMALIES AND MUTATIONS IN AMPHIBIANS. Gallien, L. (Faculte des Sciences, Paris). Annee Biol.; 8: 319-31(May-Jun 1969). (In French).

A bibliographic review is made of the most important studies on gene mutations, mutations and chromosome aberrations, and variations of the degree of ploidy (heteroploidy). Aberrations affecting the structure of the chromosomes are caused princi-

pally by irradiation of the egg or during nuclear grafting. The nature of the chromosome aberrations caused by irradiation is described. Aberrations of the karyotype in nuclear grafting are then discussed. Heteroploidy induced by thermal shocks is considered. (J.S.R.)

48493 THE MUTAGENIC ACTION OF X-RAYS ON THE EXTRACELLULAR PHAGE LAMBDA. Kriviskii, A. S.; Ktsoyan, Zh. A. (Inst. of Molecular Biology, Moscow. Inst. of Experimental Biology, Erevan). Genetika; 6: No. 3, 65-77(Mar 1970). (In Russian).

X irradiation of the extracellular resting phage λ_{11} (the multiple mutant of λ), under direct and indirect action results in increased frequency of vir-mutants. It is shown that increase of the frequency of vir-mutants is attributable neither to vir-marker rescue by prophage λ of the lysogenic cells in the bacterial lawn nor to increased radioresistence of vir-mutants. It is concluded, that there is true mutagenic action of x rays on the extracellular phage. X-ray inactivation of λ_{11} had one-hit kinetics, while mutation induction had multi-hit kinetics. When irradiation was carried out in phosphate buffer, the relative frequency of vir-mutants was higher at the same dose. Therefore one can suppose, that indirect effect of x rays makes a definite contribution to the total sum of induced mutants. At the same survival rate of the phage, there were higher frequency of vir-mutants under conditions of direct effect of x rays, apparently as a consequence of lesser frequency of double breaks of the phage DNA under these conditions of irradiation. At the maximal dose of irradiation in the broth (500 kR), when irradiated phages were plated on the strains not carrying mutations of defective repair or recombination (hcr, uvr, rec), the frequency of vir-mutants between survivors exceeded the spontaneous background 15-fold. When irradiated phages were plated on the lysogenic strains with repair or recombination defects (hcr^-, uvr^-, rec^-) the vir-mutants frequency decreased, while survival of unirradiated and irradiated phages λ_{11} and λ_{11} vir (completed vir-mutation) practically were the same in all strains (hcr^+, uvr^-, hcr^-, rec^-). It is assumed that phages, carrying premutational lesions after irradiation are completed as vir-mutants less effectively, when they develop in repair- or recombination-defective strains of bacteria compared with normal strains. (auth)

48494 MODIFICATIONS OF THE POTATO RESULTING FROM THE IRRADIATION OF THE TUBERCLES WITH γ RAYS. Chita, Ovidiu; Georgescu, Liana (Craiova Teachers Coll., Rumania). Stud. Cercet. Biol., Ser. Bot.; 21: 87-93(1969). (In Rumanian).

Experiments were carried out to obtain economically more valuable mutants of potato plants by irradiation with γ rays, to serve as starting material for further improvements. Tubercles of the Early Yellow species were exposed to γ radiation generated by a 1.8-Ci ^{60}Co source at total doses ranging from 2000 to 8000 R. The largest number of modifications were observed after exposure to 6000 R, primarily on the aerial roots. Further experiments must be made for obtaining plants suitable as starting material for tests. The nature of the induced changes and the behavior of successive generations from irradiated stock are currently under study. (TTT)

48495 BEAN MUTANT INDUCED BY IONIZING RADIATION. V. CURLY LEAF. Moh, C. C.; Alan, J. J. (Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica). Contract AT(30-1)-2043. Turrialba; 20: 120-1(Mar 1970).

Germinating seeds of Phaseolus vulgaris were irradiated with an acute dose of 2 kR of γ rays. The selfed progenies from the R_1 plants were examined for mutants. One plant segregated 15 mutants out of 56 seedlings observed. A curly leaf mutant isolated from this plant is described. The mutant was completely sterile and could only be maintained by keeping the heteroxygotes. Genetic studies showed that the curly leaf character was controlled by a recessive gene. (M.M.B.)

48496 OFFSPRING OF WOMEN WHO HAVE RECEIVED RADIATION. Zachau-Christiansen, B. Ugeskr. Laegor, 129: 279-86(Mar. 2, 1967). (In Danish).

Radiation, common in clinical practice, may cause somatic effects such as necroses, inflammations, and malignancies as well as genetic defects that may be observed in the next or a following generation. If pregnant women are exposed to radiation, their embryos or fetuses can show any of the following abnormalities: neoplastic damages, inflammations, malignancies, genetic defects, stillbirths, death of the fetus, brain damages, and diseases of the central nervous system which are apparent soon after birth. The literature contains numerous reports about workers who were professionally exposed to ionizing radiation and not only showed higher morbidity and mortality and various radiation damages but also produced offspring suffering from genetic diseases, particularly leukemia. Genetic mutations were investigated in the offspring of numerous women whose lower abdomen was irradiated shortly before or during pregnancy for therapeutic reasons or to combat sterility or induce abortion. The frequency of damages associated with irradiation was as follows: 7% of their children had heart and intestinal diseases and 5% had brain damages, epilepsy, and other diseases of the central nervous system. In another series of investigations of 269 women who were irradiated during pregnancy 10% of the children died in infancy of other than radiation induced diseases; 37% showed high mortality, particularly to loss of infection resistance; 39% were lower in weight at birth. One hundred and fifty one women exposed to x rays shortly before or after conception with 449 pregnancies were interviewed concerning their pregnancies and the health of their offspring. No statistically significant deviations from normal frequencies were reported by them with regard to abortions, stillbirths, weight of the newborn at birth, sex ratio of the newborns, infant mortality, brain damage, infectious diseases, and malformations that would indicate any radiation induced somatic or genetic change. (F.J.W.)

48497 GEMINI-XI S-4 SPACEFLIGHT-RADIATION INTERACTION EXPERIMENT. III. COMPARISON OF THE SPECTRA OF RECESSIVE LETHAL MUTATIONS AT SPECIFIC LOCI IN THE AD-3 REGION IN NEUROSPORA CRASSA. de Serres, F. J.; Smith, D. B. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 42: 471-87(Jun 1970).

Samples of asexual spores of a two-component heterokaryon of Neurospora crassa, collected on Millipore filters or in suspension, were flown aboard the Gemini-XI spacecraft in September 1966 to permit an evaluation of the genetic effects of radiation in combination with weightlessness. A ground-based experiment was performed simultaneously as a control. The samples were exposed to different amounts of ^{32}P β irradiation and survival levels and forward-mutation frequencies in the ad-3 region were studied. Characterization of the ad-3 mutants was performed by a series of genetic tests to determine the spectra of genetic alterations in the in-flight and ground control samples. These tests showed that there is no difference between the spectra of genetic alterations in the in-flight and ground samples irradiated on filters. These tests have also shown that the lower frequencies of forward-mutation in the in-flight samples irradiated in suspension were due to a specific effect on point mutations ($ad\text{-}3^R$) and not chromosome deletions ($ad\text{-}3^{IR}$). All classes of point mutations showed this same effect. These results on the spectrum of ad-3 mutation are quite different from those expected from anoxia. It is concluded that the higher levels of survival and lower frequencies of forward-mutation in the in-flight samples in suspension are due to protection against the genetic effects of radiation by weightlessness. (auth)

48498 TIME-DEPENDENCE OF THE CYTOTOXIC EFFECTS OF IRRADIATED SUCROSE SOLUTION. Kesavan, P. C.; Swaminathan, M. S.; Sharma, R. P. (Indian Agricultural Research Inst., New Delhi). Radiat. Bot.; 10: 199-205(Apr 1970).

The cytotoxic activity of gamma irradiated sucrose solution (5%) was found to inhibit significantly the eight-day growth of roots and shoots of barley seedlings and also induce chromosomal aberrations in the root tip cells of Vicia faba. Irradiated water exhibited little or no such cytotoxic activity, presumably due to the lack of formation of long-lived radiolytic derivatives of biological consequence. The potency of the induced cytotoxic activity in the irradiated sucrose solution diminished with increasing length of storage. (auth) (UK)

48499 EFFECT OF THE MEDIUM OF POST-IRRADIATION CULTIVATION ON MUTAGENESIS INDUCED BY NON-LETHAL DOSES OF ULTRA-VIOLET RAYS IN SM-LOCUS. Kondrat'ev, Yu. S. (Gamalan Inst. of Epidemiology and Microbiology, Moscow). Genetika; 6: No. 5, 111-15(May 1970). (In Russian).

Medium Frequency Distribution of uv-induced mutations to streptomycin resistance was found in glucose-deficient cultures of Escherichia coli B/r when BHI and minimal medium were used for postirradiation incubation. This MFD-like effect occurred only with E. coli B/r, not with its tryptophane deficient serotype E. coli WP2. The additional fraction of mutants, arising only on BHI, consists of small streptomycin-dependent colonies. Less pronounced effect was observed when MPA, enriched with 1% yeast extract, was used instead of BHI. (P.B.M.)

48500 LETHAL AND MUTAGENIC EFFECTS UNDER COMBINED ACTION OF UV-IRRADIATION AND HYDROXYLAMINE ON EXTRACELLULAR BACTERIOPHAGE. Kriviskii, A. S.; Tikhomirova, L. P. (Inst. of Molecular Biology, Moscow). Genetika; 6: No. 5, 84-93(May 1970). (In Russian).

Mutational curves after separate treatment with hydroxylamine (HA) and uv-irradiation of the extracellular phage sd reach the maximum at the same level of survival. By use of small doses

(more than 1 per cent survival) and combined treatment with hydroxylamine and uv irradiation results in the summation of mutagenic effects. When the second mutagen was applied after large doses (less than 1 per cent survival) of the first mutagen, a decrease of the mutation frequency was observed. Thus after combined action of mutagens there is additive mutagenic effect during the whole period of treatment. The order of the treatment with these mutagens apparently does not affect the level and kinetics of the mutagenesis. The study of the combined effect of HA and uv irradiation on the extracellular phase sd suggests that mechanisms of mutation induction by these mutagens are similar to a considerable extent. It is supposed that the majority of uv-induced mutants of phase sd arise as a result of the lesion of cytosine residues in the DNA, not as a result of thymine dimerization. The data obtained reject the hypothesis explaining the characteristic kinetics of uv-inactivation and mutation curves by the decrease of the target size in the phage as a result of disturbance of energy migration in the molecule of DNA. (auth)

48501 GENE-CONTROLLED RADIATION SENSITIVITY IN YEAST. VI. THE INFLUENCE OF THE XRS_n MUTATIONS ON THE SENSITIVITY TO UV- AND X-RAYS AND ON INDUCED MITOTIC RECOMBINATION. Zakharov, I. A.; Suslova, N. G.; Fedorova, I. V. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika; 6: No. 5, 76-83(May 1970). (In Russian).

One x-ray sensitive mutant and two uv- and x-ray sensitive mutants of the yeast Saccharomyces cerevisiae were investigated. The mutations responsible for the radiation sensitivity were nonallelic and were designated as xrs_{1-6}, xrs_{2-6}, and xrs_{4-4}. The mutation xrs_{1-6} appeared to be semi-dominant, while the mutations xrs_{2-6} and xrs_{4-4} are recessive. In haploid state, the xrs_{1-6}, xrs_{2-6}, and xrs_{4-4} mutations increased the sensitivity to the lethal effect of x-ray slightly but in diploid state they decreased the resistancy considerably. Mutations xrs_{2-6} and xrs_{4-4} increased sensitivity to the lethal effect of uv-irradiation considerably in haploid and the diploid states, xrs_{1-6} mutation in diploid state only. The diploids xrs_{2-6} xrs_{2-6}, and xrs_{4-4} xrs_{4-4} are characterized by a higher resistance to uv- and x-rays, compared to the respective haploids. The diploid xrs_{1-6} xrs_{1-6} differs from the haploid by a higher or the same sensitivity to uv- and x-rays. The rates of the uv- and x-rays induced mitotic recombination in the diploids xrs_{1-6} xrs_{1-6} and xrs_{2-6} xrs_{2-6} were also studied. The mutations xrs_{1-6} increased the sensitivity to the recombinogenic action of radiation. The mutation xrs_{2-6} decreased the sensitivity to the recombinogenic effect uv- and x-ray. (auth)

48502 ON THE APPEARANCE OF GAPS AFTER IRRADIATION OF SEEDLINGS OF CREPIS CAPILLARIS YOUNG AND OLD SEEDS AND UNDER MODIFICATION OF THE RADIATION EFFECT. Eliseenko, N. N. (Inst. of General Genetics, Moscow). Genetika; 6: No. 5, 40-7(May 1970). (In Russian).

With aging of Crepis capillaris seeds, the number of cells with aberrations increases while the number of cells with gaps decreases in gamma-irradiated seedlings. The gap fraction inducing the anaphase fragments was determined by comparing the number of fragments and gaps at metaphases and fragments at anaphases. Caffeine inhibited the gaps breakage. (auth)

48503 CHROMOSOMAL ABNORMALITIES AND IONIZING RADIATIONS. Berger, R. (Hopital des Enfants-Malades, Paris). Rev. Eur. Etud. Clin. Biol.; 15: 375-81(Apr 1970). (In French).

The main radioinduced chromosomal abnormalities are reviewed and three special aspects of the effects of ionizing radiations on the human cells are briefly discussed. The responsibility of ionizing radiations can be proposed for certain structural abnormalities, but not for numerical abnormalities, such as autosomal trisomies or monosomies. Measurement of biological dosimetry from post-irradiation chromosomal abnormalities is still very difficult despite the numerous studies in this field. Contradictions still persist between the results of the different laboratories, but a standardization of the methods should permit more uniformity in the future. Interesting results in relation to those from physical dosimetry have been obtained in cases of accidental irradiation in vivo. Finally the fate of radioinduced chromosomal abnormalities in somatic cells, and their eventual role in the induction of a malignant process is still debated. (auth) (France)

48504 REPRODUCTIVE CHARACTERISTICS OF ZEA MAYS L. PLANTS PRODUCED FROM GAMMA-IRRADIATED KERNELS. Pfahler, P. L. (Univ. of Florida, Gainesville). Radiat. Bot.; 10: 329-35(Jul 1970).

Mature, dormant kernels (moisture content = 9.52 ± 0.12%) of the single-eared single cross W19 × H55 were exposed to 0, 1, 2, 4, 8, 12, 16, 20, 24, 28, 32, 36, and 40 kR of γ irradiation. The reproductive characteristics of the plants produced from these kernels were measured. The aspects associated with pollen included fertilization ability, kernel set (dominant lethality), fertility, diameter, in vitro germination percentage, and in vitro pollen tube length. As indicated by statistical tests, only fertilization ability and in vitro germination percentage were altered by the irradiation treatments. Between 1 and 24 kR, fertilization ability was equal to or above that of 0 kR. Above 24 kR, fertilization ability was reduced so that at 40 kR the fertilization ability was about 75% of 0 kR. The in vitro germination percentage was reduced with increasing dosage, so that at 40 kR the percentage was 75% of 0 kR. Female fertility was the only aspect of female reproduction measured. Increasing doses uniformly decreased female fertility to a marked degree so that at 40 kR the female fertility was less than 10% of 0 kR. In general, the results indicated that pollen transmission was less affected by irradiation than female transmission. (auth) (UK)

48505 POST-IRRADIATION RESTORATION IN PRIMARY CYTOGENIC DAMAGE AND RADIOSENSITIVITY OF PLANTS. Valodzin, V. G.; Gardzei, I. A.; Gardzei, G. M. (Inst. of Genetics and Cytology, Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 3, 73-9(1970). (In Belorussian).

Dynamics of chromosome aberration variations in the cells of high cross bred corn Minsk-1 and its original parental forms were studied. The hybrids exhibited a reduced number of cells with chromosome aberrations during the first mitotic cycle which indicated sharply expressed reparation processes. It is suggested that the increased radioresistance of cross bred hybrids is due to their ability to restore phytogenetic damages. (R.V.J.)

48506 EXCISION-REPAIR PROPERTIES OF AN ESCHERICHIA COLI MUTANT DEFICIENT IN DNA POLYMERASE. Boyle, J. M. (Oak Ridge National Lab., Tenn.); Paterson, M. C.; Setlow, R. B. Nature (London); 226: 708-10(23 May 1970).

It was found that an Escherichia coli mutant, extracts of which showed no DNA polymerase activity, could excise pyrimidine dimers induced by ultraviolet irradiation. The increased radiation sensitivity of this strain is related to the extensive degradation of irradiated DNA. (auth) (UK)

48507 NEUTRON-INDUCED GENETIC EFFECTS: A REVIEW. Bender, Michael A. (Vanderbilt Univ., Nashville). Radiat. Bot.; 10: 225-47(Jun 1970).

Early studies of the production of gene mutations and chromosomal aberrations by neutron irradiation of various plant and animal systems suffered from difficulties in establishing neutron dose. Gene mutation studies yielded estimates of relative biological effectiveness (RBE) of less than unity. More recent work incorporating more accurate dosimetry has shown that this value is always greater than one, and has established RBE values, dose-effect kinetics and dose rate effects for a variety of genetic end-points. In spite of a rather large variability among the results reported by various authors, it appears that several rather general conclusions can be drawn, at least regarding the genetic effects of fast neutron irradiation. It seems clear that RBE values are always at least one and often much greater. RBE values are much lower for point mutations than for chromosomal aberrations in animal cells. RBE values are larger in plant than in animal cells, and similar for mutation and for chromosome aberration production, supporting the idea that most plant mutations involve chromosomal rearrangements. RBE is a function of neutron energy, increasing with increasing LET to a maximum at around 60 KeV/μ and then decreasing again at higher LET. Neutrons induce multiple-hit events which have non-linear dose-effect kinetics for low LET radiations as a linear function of dose. Neutron effects are in general much less subject to modification by other parameters, such as dose rate or oxygen tension, than are low LET radiations. Thermal neutrons deposit energy in tissue by capture rather than by production of a recoil proton, making determination of their relative effectiveness dependent on precise determinations of the energy deposited from proton and α particle production and from prompt and delayed β particle and γ ray production. Determination of thermal neutron RBE for chromosomal aberration production has yielded values about three times greater than would have been expected from the same doses of the various capture radiations given externally. The RBE for mutation production appears to be similar to that for fast neutrons. (auth) (UK)

48508 ABSTRACTS OF PAPERS PRESENTED AT THE 1970 MEETINGS OF THE GENETICS SOCIETY OF AMERICA, SEATTLE, WASHINGTON, AUGUST 24-26, 1970. Caspari, Ernst W. (ed.). Genetics, Suppl.; 6: No. 2, Part 2, 1s-132s (1970). (CONF-700814).

Approximately 200 abstracts of papers presented at the 1970

meetings of the Genetics Society of America are included. Studies are reported on genetics of Escherichia coli, Drosophila, Neurospora, maize, barley, wheat, mice, and other organisms. (H.L.W.)

48509 DEFECTIVE EXCISION REPAIR OF PYRIMIDINE DIMERS IN THE ULTRAVIOLET-SENSITIVE ESCHERICHIA COLI RAS⁻ MUTANT. Walker, James R. (Univ. of Texas, Austin). J. Bacteriol.; 103: 552-9(Sep 1970).

The ras⁻ mutant of Escherichia coli K-12 is sensitive to ultraviolet (uv) light but only slightly sensitive to x irradiation (1.5-fold increase). Other phenotypic properties include normal recombination ability and normal host cell reactivation ability but an abnormally high frequency of uv-induced mutation. The response of the ras⁻ mutant to uv was studied biochemically. After low doses of uv, the ras⁻ mutant degraded excessive amounts of DNA, and long delays in resumption of DNA synthesis occurred. Pyrimidine dimers were excised at the normal rate. Although the mutant had the capability of initiating repair replication, the process was not completed after the high uv dose required to allow detection of repair replication. The ras⁻ mutant, after low uv doses, left three to four times as many single-strand breaks not rejoined as did the wild-type strain. (auth)

48510 GENETIC MAPPING IN ESCHERICHIA COLI K-12 BY RADIATION-INDUCED CROSSING-OVER. Wann, M.; Mahajan, S. K.; Wood, T. H. (Univ. of Pennsylvania, Philadelphia). J. Bacteriol.; 103: 601-6(Sep 1970).

Conventional methods for chromosomal mapping in Escherichia coli are interruption of matings to obtain minimum marker entry times, linkage analysis of recombinants, and cotransduction. Interruption of matings has a resolution of about 0.5 min (5×10^4 nucleotides) and is not useful for distances less than about 1 min; linkage analysis of recombinants and cotransduction are capable of better resolution but are generally not very reproducible and no general theory is available for translating crossing-over and cotransduction frequencies into physical chromosomal distances. We found that when merozygotes are irradiated (x rays or ultraviolet light) soon after marker transfer, high linkage values (0.8 to 1.0) between nearby marker pairs decrease with radiation dose to 0.5. The results are quantitatively consistent with the idea that radiations induce crossing-over lesions proportional to dose, and the number of such lesions between two markers is proportional to the physical separation of the markers in the range that can also be measured by interruption of mating (0.5 to 4.0 min). Additivity relations among markers are also satisfied. This technique was used to measure the distances (0.1 to 1.0 min) between several pairs of closely linked markers. (auth)

48511 COMPARATIVE MUTAGENIC EFFECT OF ETHYLENEIMINE, NITROSOMETHYLUREA, AND ULTRAVIOLET LIGHT ON ACTINOMYCES OLIVACEUS V KX. Matselyukh, B. P.; Danilenko, I. I. (Zabolotnii Inst. of Microbiology and Virology, Kiev). Genetika; 6: No. 7, 171-3(Jul 1970). (In Russian).

Lethal and mutagenic effects of ethylenimine, nitrosomethylurea, and uv light were studied on Actinomyces olivaceus V KX. The greatest number of morphological and biochemical mutants in Act. olivaceus V KX were induced by ethylenimine. Ultraviolet light was more effective than nitrosomethylurea under the surviving dose of 0.5 to 0.001%. The mutants obtained in the number of 0.5 to 1.0% of the total required the same purines and pyrimidines: alanine, arginine, histidine, lysine, methionine, proline, cysteine, adenine, and uracil. About 85 to 90% of the mutants were methionine and cysteine dependent. (auth)

48512 PHENOTYPIC SUPPRESSION OF UV-SENSITIVITY OF ESCHERICHIA COLI B BY STREPTOMYCIN. Skavronskaya, A. G.; Smirnov, G. B. (Gamalan Inst. for Epidemiology and Microbiology, Moscow). Genetika; 6: No. 7, 111-19(Jul 1970). (In Russian).

Effect of streptomycin on uv-sensitivity of Escherichia coli B and B/r was studied. Streptomycin added to postirradiation medium in subbacteriostatic concentrations reduced the uv-sensitivity of E. coli B and increased the uv-sensitivity of E. coli B/r. Evidence was presented that this effect of streptomycin is not due to the inhibition of postirradiation protein synthesis. This effect seems to be due to the streptomycin-induced misreading of the mutated site in the fil⁺ gene of E. coli B. Analysis of the changes in uv-inactivation kinetics promoted by streptomycin indicated that the occurrence of the B/r-like fraction in the population of E. coli B is a consequence of spontaneous misreading of fil⁺ gene. This indicates that fil-gene product is a protein. It is reasonable to assume that the high uv-sensitivity of B fraction of E. coli B is due to the limited production by the fil⁺ cells of enzyme polynucleotide ligase. (auth)

48513 MUTAGENIC EFFECT OF DIFFERENT TYPES OF RADIATION ON SPERMATOGONIA IN MICE. IV. THE GENETIC EFFECT OF FAST NEUTRONS. Domshlak, M. G.; Pomerantseva, M. D.; Ramaiya, L. K. (Inst. of General Genetics, Moscow). Genetika; 6: No. 7, 73-82(Jul 1970). (In Russian).

A comparative study of the genetic radiosensitivity of germ cells of mice was made at different stages of spermatogenesis. It is shown that the post-meiotic stages are more sensitive to the fast neutrons (1,5 MeV) than the pre-meiotic (spermatogonia) are. Frequency of dominant lethal mutations linearly increased with the increase of the dose of fast neutrons for spermatozoa in the interval of 18 to 216 rad, and for spermatids (perhaps for spermatocytes) in the interval of 18 to 100 rad. For the spermatogonia, the dose effect curve of dominant lethals was not linear. The yield of dominant lethals in the spermatogonia changed insignificantly with the increase of the dose. The dose effect curve for the yield of reciprocal translocations in spermatogonia was linear within the interval of 18 to 72 rad; further increase of the dose did not induce any increase in mutation frequency. At the dose of 216 rad there was observed a sharp drop in reciprocal translocations yield. It seems likely that this phenomenon can be attributed to the selective elimination at high doses of the more mutationally sensitive cells in the spermatogonial population. The RBE of fast neutrons to x-rays for dominant lethal mutations at the post-meiotic stages and reciprocal translocations in spermatogonia was the same and amounted to about 4,5. (auth)

48514 MODIFICATIONS OF THE MUTAGENIC EFFECT OF ETHYLENIMINE AND GAMMA RAYS AT SEED EXPOSURES UNDER DIFFERENT METABOLIC CONDITIONS AT PARTIAL ANAEROBIOSIS. Dubinina, L. G. (Inst. of General Genetics, Moscow). Genetika; 6: No. 7, 61-72(Jul 1970). (In Russian).

Soaking of Crepis capillaris seeds delays germination, no cyclic phase can be observed during 96 hrs of soaking. It is suggested from the data of the radiation cytogenetic analysis that gamma radiation brought about only chromosomal type mutations. Seeds with different soaking times manifested quite regular modifications of the mutability level after receiving treatment with ethylenimine. Following the treatment, chromosomal type mutations occurred in dry seeds and also in seeds with 5 hrs of soaking. From 24 to 96 hrs, there are no mutations. Mutability in soaked seeds is a progressing of metabolic states within G_1 phase. (P.B.M.)

48515 USAGE OF THE EMBRYO TEST FOR THE ANALYSIS OF ABNORMALITIES INDUCED BY THE IRRADIATION OF ARABIDOPSIS THALIANA POLLEN GRAINS. Usmanov, P. D.; Mueller, A. (Inst. of Plant Physiology and Biophysics, Dushanbe, USSR. Research Inst. of Cultivated Plants, Gatersleben, Ger.). Genetika; 6: No. 7, 50-60(Jul 1970). (In Russian).

The embryo test methods for the investigation of abnormalities induced by radiation of Arabidopsis thaliana pollen grains are described. The pollen was irradiated by the following doses of x-rays: 8, 16, 24, 32, 40, 48, 56, 80, 160, 240, and 320 kR. The curves of dose effect were received with a count of embryo abnormalities. In the interval from 8 to 56 kR, dose effect curve is exponential, while from 160 kR dose and above it shows a plateau. The mean quantity of embryos per pod was approximately the same for all doses. However, the dose of 320 kR inhibited fertilization and the number of sterile seed buds in the pods sharply increased. The investigation of modifying influence of radiation conditions and pollen storage time upon the peculiarities of dose effect curves has shown that the storage of the irradiated pollen grains during three days did not change the final effect. However, irradiation of pollen grains in monolayer state or in the flowers decreased the mutation level per dose unit in the latter case. (auth)

48516 MUTATION VARIABILITY OF SPRING BARLEY HYBRIDS AND THEIR PARENTAL VARIETIES INDUCED BY GAMMA RAYS. Manayuk, V. T.; Kozachenko, M. R. (Inst. of Plant Industry, Breeding, and Genetics, Kharkov). Genetika; 6: No. 7, 35-43(Jul 1970). (In Russian).

A comparative study was carried out of mutability on various hybrids and their parental varieties of filmy spring two-rowed barley induced by radiation. Dry seeds were treated with 10 kr ^{60}Co gamma-rays. In M_2, various morphological, physiological, open flowered, and chlorophyll mutations were received. Compared to their parental varieties, hybrids evidenced after treatment a higher general mutability, and a higher mutation frequency in almost all groups, and mutations with normal and somewhat lower productivity. Combination variability coupled with mutation variability in hybrids allows for greater variety of forms in populations of hybrids. The varieties showed different general

mutability. The relations between frequencies of various groups of mutations are different. Therefore, the efficiency of their induction must be determined directly. Various forms have different spectra of chlorophyll mutations. A series of micro-mutations that have increased productivity or a higher resistance against lodging was isolated. Mutability of M_2-plants by their protein content of the grain is higher than in the controls. (auth)

48517 ON THE CAUSES OF THE BENDS OF DOSE-EFFECT CURVES UNDER UV-IRRADIATION OF PHAGE S_d IN VITRO. Tikhomirova, L. P.; Kriviskii, A. S.; Matvienko, N. I. (Inst. of Molecular Biology, Moscow). Genetika; 6: No. 6, 144-53 (Jun 1970). (In Russian).

The effect of multiplicity reactivation on the kinetics of the dose-effect curves under uv irradiation of the phage S_d in vitro was studied. It was shown that the survival curve under exclusion of multiplicity reactivation was exponential. The mutation curve lowers due to multiplicity reactivation of heavily irradiated phage, however the number of mutations under conditions of exclusion of multiplicity reactivation for certain lags behind the theoretically expected value according to linear dependence between the relative value of mutations and the dose of irradiation. The hypotheses explaining the turn down of mutation curves are discussed. On the basis of chemical and physico chemical data displaying a positive correlation between the arising of two neighbor lesions in the DNA, the conclusion is made that deviation of the mutation curve from the theoretically expected one can be explained by increased sensitivity of the premutational lesions in the DNA of the phage to the subsequent irradiation. (auth)

48518 RESPONSE OF HYBRIDIZED WHEAT SEEDS TO X IRRADIATION. Avakyan, V. A. (Lab. of Induced Mutagenesis of Plants, Erevan). Genetika; 6: No. 6, 177-80(Jun 1970). (In Russian).

The results of an investigation on the response of first and second generations of the hybridized wheat seeds to x irradiation are reported. A specific reaction of the hybrids and their parental forms was established. Each variety was characterized by a specific radiosensitivity. In comparison to the original seed forms the hybridized seeds manifest a higher radioresistance. It is revealed that there is a definite correlation between the gradual damaging of the cell nucleus to the productivity of the plants in M_1. (auth)

48519 ROOT SYSTEM CHARACTERISTICS IN RADIOINDUCED MUTANT LINES OF TRITICUM DURUM. Bagnara, D.; Mosconi, C.; Scarascia Mugnozza, G. T. Riv. Agron.; 3: No. 2-3, 2-7(Jul-Sep 1969). (In Italian). (RT/BIO-(70)8).

Two short straw mutants with good agronomic characteristics were isolated after treatment of caryopses of cvs. Cappelli and Grifoni with ionizing radiations. With the purpose of ascertaining whether culm length reduction is paired by some alteration of shape or dimension of the root system, observations were carried out on roots of plants at the stage of seedling, stem extension, milk-dough kernel, and maturity. Dry weights of root system and epigeic part of the plant were also determined. As far as observed characters are concerned, no difference resulted between mother varieties and respective mutant lines. No consideration was made of physiological properties of observed root system. (auth)

48520 UV-RADIOINDUCED GALACTOSE-NEGATIVE MUTANTS OF OPHIOSTOMA MULTIANNULATUM. Lindberg, M.; Sjoestroem, J. E. (Uppsala Univ.). Hereditas; 64: 251-8 (1970).

UV was used for induction of mutations in the genes controlling enzymes of the Leloir pathway. Two mutants with enzymatic blocks in the Leloir pathway were isolated. The mutants were phenotypically characterized and it was concluded that the galactose-pentose pathway is only of minor importance in Ophiostoma as compared to the Leloir pathway. (auth) (SW)

48521 STUDY OF CHROMOSOMAL ABERRATIONS IN PERIPHERAL BLOOD LEUKOCYTES AFTER THERAPEUTIC IRRADIATION. Tsaranova, L. I. (Inst. of Medical Radiology, Obninsk, USSR). Med. Radiol.; 15: No. 4, 23-7(Apr 1970). (In Russian)

The results of studies of the influence of therapeutic irradiation on chromosomes of peripheral blood leukocytes in seven patients with cancer of the esophagus and in five patients with cancer of the urinary bladder are given. The frequency of chromosomal aberrations during 48 hours of investigation after single local irradiation of patients with a dose of 300 to 400 rad and a dose of 800 to 1000 rad on the skin does not change. A comparison of the data derived with the results in vitro testifies to the fact that partial irradiation of the blood is 5 to 6 times less than the skin dose. (auth)

48522 FOUR RADIATION SENSITIVE MUTANTS OF SACCHAROMYCES. SURVIVAL AFTER UV- AND X-RAY-IRRADIATION AS WELL AS UV-INDUCED REVERSION RATES FROM ISOLEUCINE-VALINE DEPENDENCE TO INDEPENDENCE. Averbeck, D.; Laskowski, W.; Eckardt, F.; Lehmann-Brauns, E. (Freie Univ., Berlin). Mol. Gen. Genet.; 107: 117-27(1970).

Three not closely linked genes (r_1^1, r_1^2 and r_2^1), a mutation in each of which causes uv- and x-radio-sensitivity of the colony-forming ability in haploid and homozygous diploid cells have been identified. In one gene, r_1^1, two mutations occurred independently. The effect of the mutated genes on long time repair processes as well as the effect on reversion rates from isoleucine-valine dependence to independence was investigated. A model to explain the mechanisms changed by the mutated genes is discussed. (auth)

48523 TIMING OF HETEROCHROMATIZATION IN WHITE-VARIEGATED DROSOPHILA MELANOGASTER BY X-RAY INDUCED MITOTIC RECOMBINATION IN THE EYE ANLAGE. Janning, Wilfried (Univ., Munich). Mol. Gen. Genet.; 107: 128-49(1970). (In German).

Position-effect variegation of eye pigmentation in the examined $Dp(1;3)N^{264-58}$ females is due to an insertion of an X-chromosome section including the white-locus into the proximal heterochromatic region of the third chromosome. The light and dark pigmented areas have a cell lineage basis. Flies bearing the w^+-duplication had two X chromosomes marked with w^a lz^{50e} and w^a rb rux^2 respectively. X-ray induced mitotic recombination in presumptive eye cells of larvae resulted in w^a lz^{50e}/w^a rb rux^2 twin mosaic spots in the adult eyes. After young larvae were treated, twin spots appeared, which had one partner light colored and one dark. Such combinations were rarely found after older larvae were treated. Treatment of young larvae in addition produced twin spots with one or both partners variegated. Sometime after the stage at which younger larvae were treated and before the stage at which older larvae were treated the translocated w^+-gene in each cell was determined for function or no function. As a result the progeny of each of these cells synthesized pigment or not during the pupal stage. At a temperature of 25.5° C the developmental phase during which determination, i.e., "heterochromatization" of the white gene, takes place, begins not earlier than 39 hr after egg laying and ends about 8 hours later. In females heterozygous for the short arm of the heterochromatic Y chromosome linked distally to the X chromosome (Y^SX/X) one twin spot partner is homozygous for this arm (Y^SX/Y^SX), the other lacks it (X/X). The Y^SX/Y^SX partners were more frequently dark pigmented than the X/X-partners. This shows that heterochromatization of the translocated w^+-genes is markedly influenced by the genotype of the single cell. When two genotypes with varied amounts of heterochromatin were compared, no difference in the phases of heterochromatization could be observed. Therefore, when position-effect variegation is modified by varying the amount of heterochromatin in the genome the modification is probably not due to a shift in the phase of heterochromatization. (auth)

48524 FREQUENCY OF X-RAY INDUCED MITOTIC RECOMBINATION IN GENOTYPES WITH DIFFERENT X-Y-COMBINATION-CHROMOSOMES IN DROSOPHILA MELANOGASTER. Janning, Wilfried (Univ., Munich). Mol. Gen. Genet.; 107: 150-7(1970). (In German).

In first and second instar larvae of Drosophila melanogaster mitotic recombination was induced by x rays. Resulting mosaic spots were analyzed in the eyes of adult females. The five examined genotypes varied in the combination of different X chromosomes and in the presence or absence of the duplication $Dp(1;3)N^{264-58}$. X chromosomes used were elongated by proximally or distally linked arms of the Y chromosome. The portion of Y heterochromatin in the genome was negatively correlated with the frequency of twin mosaic spots. The frequency of these spots was lower in flies bearing the duplication than in those without the duplication. With respect to the X chromosome combinations, there were no marked differences in the frequencies of single mosaic spots; with respect to the duplication they were absent. In the genotype Y^SX/X. Y^S prophases of neuroblast mitoses show normal pairing of homologous chromosome sections. Reasons for the different spot frequencies are discussed. (auth)

48525 RADIOSENSITIZATION WITH IODINE COMPOUNDS. II. STUDIES ON MUTANT STRAINS OF ESCHERICHIA COLI K12 RESISTANT TO RADIOINDUCED TOXIC PRODUCTS FROM IODOACETIC ACID, POTASSIUM IODIDE, OR POTASSIUM IODATE. Kada, Tsuneo (National Inst. of Genetics, Mishima, Japan). Int. J. Radiat. Biol.; 17: 419-30(1970).

Experiments were carried out on the sensitization of strains of Escherichia coli K12 to gamma-radiation by iodoacetic acid ($ICH_2 \cdot COOH$), potassium iodide (KI) or potassium iodate (KIO_3). Gamma-irradiation of these chemicals in solution around pH 5 produced long-lived heat-labile toxic products by which bacteria were efficiently inactivated at 0°C. Mutant strains resistant to irradiated

iodoacetic acid in acid solution were isolated from an F⁻ strain, PA309. They were also resistant to radiation-induced toxic products from potassium iodide or potassium iodate, but not to unirradiated iodoacetic acid or iodine dissolved in potassium iodide solution. All three mutant strains resistant to irradiated iodine compounds were also resistant to radio-sensitization with these compounds. It is concluded that the cellular sites responsible for radiosensitization were similar in all experiments with iodine sensitizers and/or that similar radiochemical products were involved in the radiosensitization with these iodine compounds. (auth) (UK)

Health Physics and Safety

Refer also to abstracts 48391 and 48859.

Radioactive Contamination and Decontamination

Refer also to abstracts 48202, 48368, 48380, 48382, 48453–48455, 48462, 48463, 48465, 48467, 48468, 48471, 48474, 48599, and 48729.

48526 (CEA-CONF-1548) HAZARDS OF INTERNAL CONTAMINATION OF A HUMAN POPULATION FROM THE RADIOACTIVE POLLUTION OF WATERS. Bittel, R.; Lacourly, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 12p. (In French). (CONF-700505-4). Dep. CFSTI (U. S. Sales Only).

From 2nd Congress of the International Radiation Protection Association, Brighton, England.

A simple relation between the radiation doses following ingestion of contaminated food and the maximum permissible concentration in the aquatic media is established in the case of aquatic food chain and used in order to estimate the hazards by the local conditions of contamination of population groups. Therefore, a critical diet may be selected from various diets for given radioelements. The derived permissible level corresponding to this critical diet and to the given radioelement can be determined. The effects on the delivered dose of the variability of parameters (amount of ingested food, ecological and physiological transfer factors) are studied. Predictions on the effect of new nuclear installations on the contamination of food chains are given. The first data obtained by the preceding model are reported. (auth) (France)

48527 (CONF-700810-10) ENVIRONMENTAL MONITORING: BRITISH POLICY AND PROCEDURES. Dunster, H. J. (United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch). [1970]. 12p. (SM-146/25). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Monitoring of the environment is one of the techniques used in assessing the significance of releases of potential pollutants and in maintaining control over such releases. The objectives of this monitoring are complex and must be clearly defined before a programme can be designed. Two distinct types of program can be seen in connection with nuclear power — one, related to releases of substantial amounts of radioactive waste, is intended, inter alia, to determine the impact on man and, if necessary, on other organisms; the other, more qualitative, is intended to detect abnormal situations or unexplained releases of waste. The British policy on these monitoring programs is summarized and illustrated by examples of surveys for radioactive materials, thermal effects, sulphur dioxide, and ash. The wastes from power stations are controlled so that they have a very small impact on the environment, and environmental monitoring programs can therefore be fairly simple, even in the early stages of operation of a new station. After some years of experience, further simplifications, including the elimination of parts of the monitoring program, should be possible. More elaborate surveys are needed round plants for the reprocessing of nuclear fuel, because the discharges of waste are more substantial or may become so in the event of abnormal plant conditions. General principles for the design and interpretation of surveys of this type have been published by the International Commission on Radiological Protection, and form the basis of United Kingdom policy and practice. (auth)

48528 (CONF-700810-45) SOME RISKS OF MODERN LIFE. Sowby, F. D. (International Commission on Radiological Protection). [1970]. 9p. (SM-146/48). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

Concern is currently being expressed about the risks of radiation, particularly in connection with nuclear power programs. It is important that radiation risks be assessed for appropriate exposure standards to be set, so that the risk does not exceed a level judged to be acceptable. Radiation risks are viewed in relation to other risks, since radiation is but one of the many risks to which society is exposed. The magnitude of some of these risks are presented, and an attempt is made to see whether some pattern emerges that will indicate society's present conclusions about the level of acceptability and non-acceptability of risk. (auth)

48529 (ORNL-tr-2361) DECONTAMINATION DEPARTMENT ANNUAL REPORT, 1968. Krause, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report KFK-1030. 73p. Dep. CFSTI.

An abstract of the original language (German) issue of this translation appeared previously in NSA as number 24: 41641.

48530 ^{40}K IN THE HUMAN BODY IN RELATION TO ABSORBED DOSES. Guidetti, A.; Indelicato, S. (CESPRE, Rome). Minerva Med.; 61: 689-93(21 Feb 1970). (In Italian).

Clinical, histopathological, biophysical, and experimental research carried out by the Cespre into premorbid and precancerous conditions includes the investigation of elements, in particular ^{40}K, in the human body. This question has been studied in America and Rome for a number of years by Sascha Guiglia. Mention is also made of a paper presented by Chiurco to the Brussels International Surgery Congress at Mexico City (1957). In the present paper reference is made to body ^{40}K content and activity (absorbed dose) in terms of Title 3, chap. III, art. 12 of the rules for the protection of public health drawn up by the European Community Atomic Energy Council (2-2-1959). Note is taken of the fact that the calculated dose (3 rem in 70 yr) is less than the permitted maximum ^{40}K dose (5 rem in 30 yr). It is felt, however, that the observed level should not be underestimated since it expresses both a continuous and constant action as well as particular concentrations in certain areas. Further work is to be carried out at the Center. (auth)

48531 EVALUATION OF VEGETABLE FOODS AFTER TREATMENT FOR RADIOACTIVE DECONTAMINATION. Paulus, K. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Lebensm.-Untersuch. Forsch.; 142: 17-24 (Feb 1970). (In German).

The suitability of fruits and vegetables for human nutrition was examined after removal of radioactive contamination. Chemical analyses showed that the nutritive value was impaired by leaching and heat and consequently less than that of products prepared by conventional methods. Nutritive values of the decontaminated foods were nonetheless acceptable. (auth)

48532 DETERMINATION OF POPULATION BURDEN BY NATURAL EXTERNAL RADIATION ON THE TERRITORY OF THE G. D. R. (MEASUREMENTS WITHIN BUILDINGS). Ohlsen, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie; 13: 91-6(Mar 1970). (In German).

Local dose rate measurements of the natural external radiation within buildings were described. The measuring devices were an air-equivalent ionization chamber having a volume of 23 l and a scintillometer. To evaluate the average burden of population within houses the results of the measurements were associated with the individual types of houses and weighted according to the fraction of population living there. Using this, the average burden of population due to natural external radiation (neutrons excepted) within buildings was found to be 106 mR/year. Evaluation of the average gonad burden of total population including both former results of outdoor measurements of the terrestrial and cosmic radiation and literature data about neutron radiation amounted to 91 mrem/year. Good agreement was obtained with respect to international data about the terrestrial and cosmic component. (auth)

48533 ^{85}Sr DECORPORATION WITH A CRYPTATING AGENT. Mueller, W. H. Naturwissenschaften; 57: 248(May 1970).

A new chelating agent, Sr-cryptate, removed approximately 80% of the 2.5 μCi ^{85}Sr from rats within three days of administration. Urinary excretion exceeded fecal excretion of ^{85}Sr during the first day, but dropped rapidly to values lower than those for feces on the 2nd and 3rd days. The hexaoxa-diamine macrobicycle I appeared to be especially suited for strontium decorporation because of increased stability of the Sr complex in comparison to the corresponding Ca compound. (P.B.M.)

48534 URANIUM CONTENT OF NORMAL BLOOD. Hamilton, E. I. (Radiological Protection Service, Sutton, Eng.). Nautre (London); 227: 501-2(1 Aug 1970).

Reference is made to reports on the concentration of U in freeze dried and whole blood. The figures given by Carpenter and Cheek, (Anal. Chem. 42: 121(1970)) are considered very high, unusual, and not representative of "normal" human blood.

Results obtained at RPS by the fission track and delayed neutron methods are tabulated; an average U concentration of 8.4×10^{-10} g/g whole blood was obtained, which is two orders of magnitude lower than the value given in the above reference. The techniques adopted are described. Examination of about 60 samples of dried blood from various localities in the UK and Greenland by the delayed neutron screening technique failed to detect any U, and quantitative assay for U in blood was only possible by utilising the ash from >150g of dried blood. The figures of Carpenter and Cheek are equivalent to an activity concentration of 150pCi/kg for both ^{238}U and ^{234}U together with a small contribution from ^{235}U amounting to a total α-activity of about 300pCi/kg dried blood. This is very high compared with reported measurements of the specific α-activity of freeze dried blood, which indicate a concentration of about 50pCi. It should be noted that the most of the α-activity in blood is considered to arise from Th. The mechanism of uptake of U from diet is discussed. Possible explanations for the high results of Carpenter and Clark are also discussed, and it is concluded that the samples of blood used were not "normal", or had been contaminated with fissile nuclides that could give rise to fission tracks. It is stated to be important to define adequately the environmental background of human tissue samples in order to assess the normal concentration of an element present in the tissues, and at present insufficient information is available, except for a few elements, to permit scientific evaluation. Until these factors are known with reasonable certainty there is a danger of using scanty data for evaluating relations between the concentration of elements in biological samples and deleterious effects to man. (UK)

Dosimetry and Monitoring

Refer also to abstracts 48199, 48259, 48263, 48383, 48438, 48632, 48648, and 50198.

48535 (BNWL-1183-5) MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report to the NASA Manned Spacecraft Center, April 6-July 5, 1970. Brodzinski, R. L.; Haller, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Jul 1970. Contract AT(45-1)-1830. 27p. Dep. CFSTI.

The urine and feces specimens from the Apollo 13 mission were analyzed for their radionuclide content. Estimates of the cosmic radiation dose received by the astronauts are not accurate due to the low concentrations of the long-lived cosmogenic radionuclides; however, a comparison of the Apollo 13 radionuclide concentrations to those of the Apollo 9 mission yields a dose of <250 mR for the Apollo 13 mission astronauts. The concentrations of ^{7}Be, ^{22}Na, ^{40}K, ^{55}Fe, ^{60}Co, and ^{137}Cs were determined. The ^{40}K, ^{55}Fe, and ^{137}Cs concentrations in three of the fecal specimens were high compared to previously observed levels, while all other radionuclide concentrations in both feces and urine remained comparable. No ^{147}Pm was observed in any of the samples. It is recommended that in the future at least half of the 24-hour urine collections be used for radionuclide analyses. The concentrations of the radioisotopes observed in the feces from the Apollo 7 through 11 missions and the urine from the Apollo 11 and 12 missions were normalized to the weight of the respective inert element in the specimen. These newly normalized concentrations confirmed all prior conclusions regarding assignment and identification of samples, anomalously high and low concentration of radionuclides, times of injections of radionuclides, increases and decreases of excretion rates as a function of time, and cosmic radiation doses. The concentrations of Na, Rb, Cs, Co, Zn, Br, and Se in the urine specimens from the Apollo 12 mission are reported. The daily excretion rates of calcium, potassium, and iron for astronauts from the Apollo 7 through 11 missions are found to be higher than the intake rates by factors of 2.24, 1.54, and 2.2 respectively. The imbalance determined for these three elements strongly dictates the necessity of determining the concentrations of the microconstituents in the foodstuffs. An immediate analysis of the foodstuffs by neutron activation analysis is recommended. Whole blood samples should be collected from each astronaut before, during (if possible), and after each mission for activation analysis of major, minor, and trace elements in order to compare concentrations in the body serum with excretion rates. The fecal samples from the Apollo 13 mission were analyzed for their glass fiber content. The observed concentrations and total weights of glass fall within the range of results reported for previous missions with but one anomalous sample which had large quantities of extremely long fibers in it. A piece of the outer thermal coating of the Apollo 7 spacecraft was analyzed for cosmic-ray-induced radioactivity 77 days after splashdown; no radionuclides were observed. (auth)

48536 (BNWL-1307(Pt.2), pp 1-4) INHALATION HAZARDS TO URANIUM MINERS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

The documented high incidence of lung cancer and respiratory ailments in uranium miners requires the investigation and measurement of the gross composition and particle size of the organic and inorganic aerosols to which the miner is exposed. (auth)

48537 (BNWL-1307(Pt.2), pp 50-1) RADIATION DOSIMETRY. Braby, L. A.; Fleming, D. M.; Glass, W. A.; Nichols, L. L.; Roesch, W. C.; Toburen, L. H.; West, M. L.; Wilson, W. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

This study is primarily concerned with determining how to measure radiation to obtain correlation with biological effects. This is done by conceiving physical quantities that may serve the purpose, studying the principles that relate them to others previously known, determining how they are to be measured, and establishing how useful they are in correlating biological phenomena. (auth)

48538 (BNWL-SA-3233-A) THE DOSE FROM ^{85}Kr RELEASED TO THE EARTH'S ATMOSPHERE. Hendrickson, M. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1970. 15p. (CONF-700810-16; SM-146/12). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The total body exposure rate was calculated for immersion in ^{85}Kr. The exposure from both gamma rays and from X-rays produced from Bremsstrahlung was accounted for. Immersion exposure for one year to a semi-infinite cloud of ^{85}Kr with an activity concentration of 3×10^{-6} $\mu Ci/cm^3$ would result in a calculated dose of 75 mrem. In numerous instances $^1/_{10}$ the above concentration has been equated to a total body exposure rate of 500 mrem per year when in fact a continuous concentration of 3×10^{-7} $\mu Ci/cm^3$ is calculated to give a total body exposure rate of only 7.5 mrem per year. The reason for the numerous overestimates of the projected total body dose is traceable to use of the Committee II Recommendations of the ICRP for immersion dose calculations. The ICRP-recommended method gives valid estimates of the dose for mixtures of inert gas isotopes which are primarily gamma emitters, not beta emitters. The method also gives a valid estimate of the skin dose for beta emitters. Several projections of nuclear power growth have indicated a remote possiblity of ^{85}Kr concentration in the earth's atmosphere eventually reaching 3×10^{-7} $\mu Ci/cm^3$ in about the year 2050. Programs have been instituted to develop methods of preventing ^{85}Kr release. The question which must be answered is: "Does a total body dose administered at the rate of 7.5 mrem per year constitute enough exposure to warrant the present alarm and the expensive programs to control the release of krypton to the atmosphere?" Using currently popular estimates of the growth of power production, release of ^{85}Kr into the atmosphere could conceivably cause a total body dose (or genetically "significant" dose) of about 0.03 mrem in the year 2000. (auth)

48539 (CEA-CONF-1554) DOSE DISTRIBUTION OF PRIMARY NEUTRON COLLISION IN TISSUE AS A FUNCTION OF LINEAR ENERGY TRANSFER. Dousset, Marc H.; Hamard, Jean; Ricourt, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 26p. (In French). (CONF-700505-12). Dep. CFSTI (U. S. Sales Only).

From 2nd Congress of the International Radiation Protection Association, Brighton, England.

In order to contribute to the interpretation of the radiobiological data obtained when thin samples of tissue are exposed to neutrons, the first collision dose distribution as a function of LET was calculated for monoenergetic neutrons with energies between 0.025 eV and 10 MeV. From the results obtained the same distribution for neutrons with complex energy spectrum may be easily calculated. (auth) (France)

48540 (CONF-700810-6) EVALUATION OF POTENTIAL HAZARDS FROM TRITIUM WATER. Bond, V. P. (Brookhaven National Lab., Upton, N. Y.). Jul 1970. 25p. (SM-146/13). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The possible biological effects of tritium are analyzed, and several factors that must go into an evaluation are considered both from the theoretical and experimental standpoints. Maximum permissible concentrations or maximum permissible doses of tritium are based principally on the absorbed radiation dose delivered by the tritium β rays. Several possible factors that might increase the degree of toxicity over that expected from the ab-

sorbed dose are considered in detail. These include the possibility of biological concentration of tritium, or of additional toxicity by virtue of the fact that some tritium may be incorporated into biological molecules such as DNA. The conclusion is reached that these factors do not significantly increase the effective dose that might be expected from a given concentration of tritium in the environment. A given absorbed dose of radiation from the β rays of tritium (from either inhalation or ingestion) has the same radiobiological and radiation protection meaning as the given dose from x rays or γ rays (same dose rate pattern), and little or no added significance or potential hazard need be attached by virtue of the fact that the dose may have been derived from tritium. The dose to the public from tritium and other isotopes released from nuclear power plants is discussed in relation to the maximum permissible dose to the public from all radiation sources, and in the context of doses received now and in the future from nuclear power plants. (auth)

48541 (PAEC(D)-702) DOSIMETRY STUDIES OF ^{60}Co FACILITY. Bustamante, Norma T. (Philippine Atomic Energy Commission, Manila). Mar 1970. 18p. Dep. CFSTI (U. S. Sales Only).

Circular mapping of the Co-60 facility in the Philippine Atomic Research Center was done using a Victoreen Condenser Roentgen Meter. Measurements were made at various horizontal distances from the source. Vertical mapping was also done to determine the percentage change in dose-rate with increase in vertical distance above the platform. At distance closer to the source, beyond the range of the Victoreen Condenser Roentgen Meter, ferrous sulfate chemical dosimeter was used. The reproducibility and accuracy of the chemical dosimeter as well as the effect of scatter on the dose-rate was studied. The theory of operation of the Victoreen Condenser R-meter and principles involved in the use of the chemical dosimeter were also discussed. (auth)

48542 (STI/DOC-10/110) MANUAL OF DOSIMETRY IN RADIOTHERAPY. A Practical Guide for Testing and Calibrating Equipment Used in External Beam Treatments. Massey, John B. (International Atomic Energy Agency, Vienna (Austria)). Jun 1970. 147p. IAEA $4.00.

This manual is intended as a practical guide to the procedures necessary for achieving good physical accuracy of irradiated volume and dosage in external beam therapy. It was prepared for the guidance of radiologists working in radiotherapy centers where there is no well-equipped, well-staffed and experienced full-time physics services. Topics discussed include the calibration and use of dosemeters, methods for the measurement of x radiation and γ radiation for ^{137}Cs and ^{60}Co teletherapy units, methods for the measurement of radiation quality, and methods for the radiation protection of medical personnel and patients. (C.H.)

48543 (SWRHL-92-r) SUMMARY OF HYPOTHETICAL WHOLE-BODY GAMMA EXPOSURES AND INFANT THYROID DOSES RESULTING OFF-SITE FROM PROJECT ROVER NUCLEAR REACTOR/ENGINE TESTS AT THE NUCLEAR ROCKET DEVELOPMENT STATION. Grossman, R. F. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Aug 1970. 19p. Dep. CFSTI.

From 1959 through 1969, thirty-one nuclear reactor engine tests, conducted at the Nuclear Rocket Development Station (NRDS) as part of Project Rover, released airborne radioactivity which was detected in the area surrounding the Test Range Complex (NRDS, Nevada Test Site, Tonopah Test Range, and Nellis Air Force Range). For these tests the Southwestern Radiological Health Laboratory (SWRHL) performed radiological monitoring and sampling. From the radiation exposure information reported by SWRHL, whole-body gamma exposures and infant thyroid doses were postulated for hypothetical receptors and summarized by year and sector from NRDS. A comparison of the Radiation Protection Standards of AEC Manual Chapter 0524 with this summary indicated that for each year of testing, the off-site whole-body exposures and infant thyroid doses were below 12% and 14%, respectively, of the Radiation Protection Standards for a population sample. (auth)

48544 (SWRHL-96) PUBLIC HEALTH EVALUATION, PROJECT RULISON (PRODUCTION TESTING). Evans, Roy B.; Bernhardt, David E. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). May 1970; Second Printing Aug 1970. 87p. (PHEP-1; PNE-R-34). Dep. CFSTI.

Project Rulison is a Plowshare experiment to investigate the feasibility of nuclear explosive stimulation of natural gas production. The detonation of the explosive took place on September 10, 1969. Production testing activities will be initiated six months or more after the detonation and will entail flaring of natural gas containing radioactivity. The radionuclides of primary interest that will be released by production testing are tritium and ^{85}Kr. An analysis of the public health implications of the radioactivity releases associated with Project Rulison production testing is presented. Concentrations and possible movement of radionuclides in ground water near the chimney are estimated, and potential human doses from radioactivity released to the atmosphere during production testing are postulated. The analysis presented indicates that Project Rulison production testing operations can be conducted well within the radiological safety guides of the Federal Radiation Council and Atomic Energy Commission. The postulated dose to members of the public is on the order of one-tenth mrem. (auth)

48545 RAPID ESTIMATION OF ^{241}Am CONTENT IN PLUTONIUM. Delpizzo, R. G.; Owen, J. B.; Putzier, E. A. (Dow Chemical Co., Golden, Colo.). Health Phys.; 18: 725-7(Jun 1970).

The accuracy of body counter measurements to determine a plutonium lung burden by measuring 60 keV ^{241}Am γ rays is highly dependent on the determination of the ^{241}Am content of the plutonium aerosol to which an individual was exposed. Various methods of measurement are discussed and the errors and difficulties arising are detailed. A method to overcome these shortcomings is described in which the ^{241}Am content is determined from a ratio of counts from the 60 keV ^{241}Am γ rays to the counts from the combined x rays associated with the radioactive decay of ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Am. The equipment, method, and theory are discussed. (UK)

48546 EVALUATION OF ACCIDENTAL PERSONNEL EXPOSURE TO ^{238}Pu: WHOLE BODY COUNTING AND BIOASSAY RESULTS. Anderson, H. F. (Monsanto Research Corp., Miamisburg, Ohio); Sheehan, W. E.; Mann, J. R.; Bistline, R. W. Contract AT(33-1)-GEN-53. Health Phys.; 18: 631-9(Jun 1969).

An explosion inside a ^{238}Pu glove box line at Mound Laboratory resulted in significant inhalation exposures being received by three personnel. The three employees were sent to the Dow Chemical Company's Rocky Flats site for whole-body counting three weeks after the incident. Whole-body counting measurements were made using the 17 keV (average) x ray associated with the decay of ^{238}Pu. These measurements indicated that the employees had lung burdens of 0.134, 0.141, and 0.091 μCi. The urine data obtained on these three employees during the first 180 days post-exposure are given. These data show an elimination pattern that differs from the pattern observed in previous inhalation exposures to ^{238}Pu at Mound Laboratory. Long-term systemic burdens are estimated to be 0.03, 0.29, and 0.21 μCi. (auth) (UK)

48547 CONCERNING THE RELATIONSHIP OF ^{210}Pb AND INHALATION EXPOSURE OF ^{222}Rn. Raabe, Otto G. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Health Phys.; 18: 733-4(Jun 1970).

The quantitative relation between body burden of ^{210}Pb in uranium miners and their cumulative exposure histories proposed by Fisher (NSA 23: 26788) is discussed. It is claimed that the conversion factor used by Fisher can be wrong by more than an order of magnitude. It is also suggested that he erroneously treated as unimportant the actual concentration of ^{210}Pb and other sources of ^{210}Pb, such as the radon gas that diffuses into the body fluids and the physical contamination of the miners with ^{210}Pb. Some ideal cases of various levels of mine ventilation are considered to illustrate the discrepancies. It is concluded that there is a useful, though somewhat rough, relation between working-level-months of exposure to radon progeny and ^{210}Pb body burdens. However, the inability to rigorously equate ^{210}Pb burdens to working-level-months of exposure even if there were no complications in describing lead retention may explain much of the observed variability in attempting to correlate these measurements. (UK)

48548 PROBLEMS OF THE RADIATION SAFETY OF PERSONNEL OF SURGICAL WARDS PARTICIPATING IN RADIOLOGIC PROCEDURES. Golikov, V.; Zolnikova, N. I.; Luboshnikova, T. I. Grud. Khir.; 9: 102-4(May-Jun 1967). (In Russian).

Many physicians, nurses and technicians who have not received radiological training have been called upon to carry out radiological treatments and investigations. The hands of surgeons who operate while checking the results on a fluoroscopic screen may be exposed to dose rates of 18 R/min. In order to determine the potential radiation burden of medical personnel, the diagnostic radiology departments in large medical research centers were surveyed. The work carried out involved primarily bronchoradiography, angiopulmonography and similar tests. A personnel film dosimeter with a range from 0.02 to 2 R was used for the measurements. It was found that the surgeons, physicians and anesthesiologists were exposed to 20 to 150 mR/week, with an average of 50 to 70 R/week; this is much higher than the maximum permissible

level for the population at large, although less than the permissible level for professional exposure. The dose may be reduced by spreading the work to a larger number of physicians. It is recommended to eliminate as far as possible operations involving fluoroscopic techniques, using electronic image amplifiers for control, to enforce the use of suitable shields and to keep exact personnel exposure records by means of individual dosimeters. Special care should be taken to protect the fingers of surgeons, keeping them out of the direct beam. (TTT)

48549 DOZIMETRIYA IZLUCHENII INKORPORIROVANNYKH RADIOAKTIVNYKH VESHCHESTV. (Radiation Dosimetry of Incorporated Radioactive Substances). Osanov, D. P.; Likhtarev, I. A.; Radzievskii, G. B. Moscow; Atomizdat (1970). 184p.

Methods for calculation of absorbed tissue doses of γ and β radiation follow incorporation of ^{137}Cs, ^{89}Sr, ^{32}P, and ^{239}Pu are described. The basic physical and biological laws of isotope transport in the human organism following inhalation or uptake through intestinal tract or skin are discussed. Methods for measuring the whole-body activity of humans are described and data on maximum permissible concentrations of the radioisotopes in critical organs and tissues are included. (227 references) (R.V.J.)

48550 REVIEW OF CURRENT PROGRESS IN THE ASSESSMENT OF PLUTONIUM LUNG BURDEN. Tomitani, Takehiro. Nippon Genshiryoku Gakkaishi; 12: 322-30(1970). (In Japanese).

The present status of progress in methods of assessment of the Pu lung burden is reviewed, and a discussion is given on the difficulties encountered in the assessment e.g., those that are inherent to high-sensitivity counting of low energy x rays, those due to the differences in the isotopic composition of various Pu isotopes, and Am that is encountered in the calibration of the detection efficiency for low energy x rays. (auth)

48551 USE OF THE COMPUTER IN RADIOTHERAPY. I. CALCULATION OF THE PERCENT DOSE AT THE AXIS IN COBALT TELETHERAPY. Milanesi, Renato (Istituti Ospitalieri, Verona, Italy); Pasoli, Armando; Puppini, Gianni; Cabassa, Nino. Fracastoro; 62: 309-19(Jul-Aug 1969). (In Italian).

Different methods for estimation of the dose to the axis during cobalt-60 radiotherapy were investigated. The results obtained by the use of a proposed formula are presented. This method appears to improve the precision of dose estimation. (M.M.B.)

48552 SURVEY OF RADIOACTIVITY OF OSAKA BAY. Ueno, Teruo; Toratani, Hirokazu; Yoshizako, Fumiki; Nishimura, Atsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 86-9 (1969).

Survey of the radioactivity in Osaka Bay has been performed since 1962. The samples investigated were floating organisms (planktons) and marine deposit (sea mud) as well as flat fishes and arkshells in Osaka Bay. A remarkable change of radioactivity was not recognized as a whole. The relatively high counting rates of planktons in 1963 which were probably due to the influence of a series of nuclear explosion tests were observed. (auth)

48553 STRUCTURE OF SEMISHADOW. Dmokhovskii, V. V. (Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol.; 15: No. 8, 70-4(Aug 1970). (In Russian).

The distribution of radiation by semishadow is an integral of function of radiation distribution along the source. With the aid of filters of variable transverse section one could increase part of the field, ensuring a practically regular irradiation and reducing the radiation dose to the adjacent healthy tissues. (auth)

48554 ISODOSE MEASUREMENT FOR ^{60}Co EYE APPLICATORS. PART II. GENERAL CALCULATIONS OF DEPTH DOSE FOR CIRCULAR AREA ACTIVITY AND MEASUREMENT FOR APPLICATOR CKA 8-11. Rassow, J.; Strueter, H.-D.; Magnus, L.; Goebbeler, T. (Ruhr Univ., Essen). Radiol. Clin. Biol.; 39: No. 1, 32-46(1970). (In German).

A calculation method of depth doses along the symmetry axis, valid for any circular plane sources, more general and at the same time simpler than the approximate calculations used by Magnus (1967, 1968), but which under equal conditions leads to almost identical results is described. By means of gradation- and quality curves a film-dosimetric method is discussed which allows with only two films each time to measure relative dose differences of 100 : 1 within 5% accuracy. These measured depth dose curves for the ophthalmic applicators CKA 8-11 agree satisfactorily with the calculated values. The complete dose distributions in the symmetric and asymmetric principal planes of the applicators are illustrated. The isodoses in both planes show the characteristic shape according to the distance of the activity center from the axis of the applicator. (auth)

48555 CONSTRUCTION OF AUXILIARY DIAPHRAGMS FOR MEGAVOLTAGE IRRADIATION OF LARGE, IRREGULARLY SHAPED FIELDS. van Dorssen, J. G.; Mellink, J. H.; Thomas, P. (University Hospital, Leiden). Radiol. Clin. Biol.; 39: No. 1, 47-53(1970).

A method is described by which individual auxiliary diaphragms can be constructed easily and inexpensively for each patient. Any desired shape can be made with this method, no matter how irregular the outline of the field. The transmission penumbra is also reduced, and the reproducibility of the shielding for daily radiation treatment is guaranteed. (auth)

48556 RADIATION SURVEILLANCE: MONITORING THE ENVIRONS OF A NUCLEAR STATION. Oyen, Larry C. (Iowa-Illinois Gas and Electric Co., Davenport, Iowa). Mech. Eng.; 92: No. 8, 32-7(Aug 1970).

The environmental radiation monitoring program developed for use near the Quad-Cities (Illinois) nuclear power plant, which will be completed in 1971, is described. The topics discussed include: objectives of the program; types of measurements to be made; and sampling equipment and procedures for the radiation monitoring of air, groundwater, surface waters, vegetation, soil, and key foods such as fish, milk and vegetables. (L.C.L.)

48557 DOSE FIELDS IN ROTATION GAMMA-IRRADIATION OF HOMOGENOUS AND HETEROGENOUS PHANTOMS OF HUMAN CHEST. Skoropad, Yu. D. (Inst. of Medical Radiology, Moscow). Med. Radiol.; 15: No. 8, 77-81(Aug 1970). (In Russian).

The results of measurements of dose fields in homogenous and heterogenous phantoms in rotation irradiation of the upper third of the esophagus at a 90° angle with a ^{60}Co source are reported. It is shown that between the measured fields there is a difference, which is not eliminated after correction for heterogeneity in the dose field, measured in a homogenous medium. (auth)

48558 TISSUE DOSES IN THE HUMAN GASTROINTESTINAL TRACT OF PENETRATION INTO THE ORGANISM OF RADIOACTIVE SUBSTANCES. Osanov, D. P. (Inst. of Biophysics, Moscow). Med. Radiol.; 15: No. 8, 40-7(Aug 1970). (In Russian).

Methods for calculation of tissue doses in the human gastrointestinal tract are discussed, which take into consideration, along with the time of presence of the contents in different regions, its continuous movement and absorption. An assessment of the influence of properties of radioactive isotopes on the value and kinetics of formation of tissue doses is given. (auth)

48559 PREPARATION OF CHARTS AND CALCULATION OF DOSES IN TELEGAMMATHERAPY. Pereslegin, I. A.; Sarkisyan, Yu. Kh. (Second Moscow Inst. of Medicine). Med. Radiol.; 15: No. 8, 65-70(Aug 1970). (In Russian).

A technique is described for preparing charts of isodoses and calculating doses in telegammatherapy through a lead screen. The figures and illustrations enable to comprehend the radiation energy distribution under the lead screen depending upon conditions of irradiation (number of fields and angles of inclination of the radiation beam). The technique of irradiation is described. (auth)

48560 ASSAY OF ^{113m}In IN MEDICAL APPLICATIONS. Husak, Vaclav; Kleinbauer, Karel (University Hospital, Olomouc, Czech.). Jad. Energ.; 16: 135-9(1970). (In Czech).

The basic physical characteristics of ^{113m}In are summarized using the latest published data and both methods recommended by producers of generators and methods suggested for clinical practice are described. Metastable indium-113 is assayed by comparing it on the scintillation spectrometer with standards of ^{133}Ba, ^{131}I and ^{198}Au. The same methods may be used for determining ^{113}Sn in the eluate. The scintillation detector calibrated by the known amount of ^{113m}In proved to be useful for the routine assay of this radioisotope in clinical practice. (auth)

48561 NEW CHEMICAL METHOD FOR THE DETERMINATION OF THE DOSE RATE OF VARIOUS TYPES OF RADIATION. Vladimirova, M. V.; Kulikov, I. A. At. Energ. (USSR); 28: 429-31(May 1970). (In Russian).

There is a great interest in the chemical dosimetry of radiation sources, such as accelerators and reactors which possess dose rates higher than 10^4 rad/sec. It was found that the yield of HNO_2 from the radiolysis of 4M nitric acid solution and the resulting steady-state concentration of nitrous acid is related to the dose rate and is the same for both α and γ radiations; it may be used for dose rate measurements. Care must be taken to determine the temperature exactly as it affects the results. The nitrous acid concentrations were measured spectrophotometrically. The method is suited for determination of the dose rate above 10^3

rad/sec because measurements at lower levels require long exposure times. The minimum time required for measuring the dose rate at the 5×10^3 rad/sec range is 3 hr; at 1×10^4 rad/sec level it is 2 hr and at 1×10^6 rad/sec 0.5 hr. The experimental error amounted to 10 to 15%, assuming that the temperature was measured with a precision of 1°C. (TTT)

48562 NEUTRON DOSE FROM AN ISOTROPIC POINT FISSION SOURCE. Khovanovich, A. I.; Kokovikhin, V. F.; Kondurushkin, N. A.; Belovintsev, V. Ya. At. Energ. (USSR); 28: 501-2(Jun 1970). (In Russian).

The fission neutron spectrum was broken down into groups in calculating the dose. The biological neutron dose in ber (biological equivalent rads) is given by the following equation: $D = (k/R^2) \exp(-R\rho/\lambda\rho_0)$. Here k is a proportionality coefficient; λ is the effective length of attenuating the neutron dose in air in meters; ρ_0 is the density of air under standard conditions equal to 1.293×10^{-3} g/cm^3; ρ is the actual density of air; R is the distance between the source and the detector in meters. At R < 300 m from the source the value of k is 4.6×10^{-14} for somatic effects and 2.8×10^{-13} for genetic effects. The value of λ is infinite. At 300 < R < 1200 the value of k is 1.9×10^{-12} for somatic effects and 1.0×10^{-12} for genetic effects. The value of λ is 205. Expressions are given for the neutron spectrum in air at distances of 100 to 1000 m from the source. (TTT)

48563 RADIATION QUANTITIES AND THEIR SIGNIFICANCE IN HEALTH PHYSICS. PARTS 1 AND 2. Neufeld, Jacob (Oak Ridge National Lab., Tenn.). Health Phys.; 19: 253-79(Aug 1970).

A critical appraisal is made of quantities and units in radiation protection work and a different approach is suggested for establishing permissible limits of radiation exposure. There is an ambiguity in the current health physics terminology, particularly with reference to such quantities as dose equivalent. It is pointed out that dose equivalent has been specified for a macroscopically small volume element Δv around a point r in a medium which can be a phantom or a human body. In such cases dose equivalent has been assumed to vary from one point to another; it is therefore a field quantity, representing a condition spacially distributed in a medium. There exists, however, another quantity erroneously called dose equivalent which is not a field variable but a single numerical entity. This other quantity, which for all practical purposes has remained anonymous, represents the amount of exposure and is related to what is known to be the maximum permissible dose (MPD). There is also confusion in speaking about the quality factor (QF). The name quality factor is currently used to represent several quantities, conceptually different one from the other, and the usefulness of some interpretations of the (QF) is open to question. It is shown that the relationship between the dose equivalent and the quality factor recommended by the International Commission on Radiation Units and Measurements (ICRU) is not that which is used in health physics calculations; there is therefore a discrepancy between the official and the non-official points of view. The assumptions which lead to the derivation of the quality factor and of other similar concepts are analyzed from an operational and more particularly from an instrumental point of view. It is proposed that a "quality index" $Q = D_e^{eff}/D_r$ be defined where D_r is the "reference dose" to be used in monitoring a radiation field and D_e^{eff} is the "effective dose equivalent" which is the name given in this analysis to the "amount" of exposure. (UK) (TSS)

48564 STOPPING POWER AND RANGE OF ALPHA PARTICLES Walsh, P. J. (National Inst. of Environmental Health Sciences, Research Triangle Park, N. C.). Health Phys.; 312-16(19 Aug 1970)

The stopping power of tissue for alpha particles is calculated on the basis of presently available information. The application of Bragg's additivity rule is refined by taking into account charge exchange effects using experimental data for protons and alpha particles interacting with various atoms and molecules to predict the interaction of alpha particles with the elements composing soft tissue. The results are summed to obtain the stopping power of soft tissue for alpha particles. (auth) (UK)

48565 GENERAL EXPRESSION FOR MEGAVOLTAGE C CENTRAL AXIS DEPTH DOSES. Thomas, R. L. (Addenbrookes Hospital, Cambridge, Eng.). Brit. J. Radiol.; 43: 554-7(Aug 1970).

An expression is presented which may be used to generate tissue-air ratios and percentage depth doses for megavoltage radiotherapy beams from ^{60}Co γ rays to 15 MV X rays. The accuracy achieved is considered to be acceptable for all clinically important field sizes and for depths which are greater than the maximum electron build-up depth. (auth) (UK)

48566 DOSIMETRY OF IRREGULAR FIELDS IN ^{60}Co THERAPY. Aral, I. M.; Cail, D.; Nissel, M.; Spira, J. (Boston Univ.). Acta Radiol, Ther., Phys., Biol.; 9: No. 1, 24-32(Feb 1970).

Output versus field size and the dose distribution with cobalt 60 γ teletherapy units was experimentally measured for irregular fields commonly used in clinical radiotherapy. The results indicate that the dosage across large-shaped fields and under commonly used blocks cannot be predicted from tables but should be determined individually for such fields and their respective blocks. (auth) (Sweden)

48567 DOSE CONVERSION FACTORS FOR USE WITH IONIZATION DOSE METERS FOR 6 TO 35 MeV ELECTRON BEAMS. Kartha, M. (Ohio State Univ. Hospitals, Columbus, Ohio); MacDonald, J. C. F. Brit. J. Radiol.; 43: 549-53(Aug 1970).

The use of high-energy electrons in cancer therapy has created a need for sensitive and accurate dosimetric techniques which are applicable to the measurement of electron beams. The most logical first step is to extend the use of ionization chambers in order to measure high-energy photon and particulate beams. This article deals with a comparative study of chemical and ionization systems. The method and results of an investigation to determine conversion factors for use with commercial ionization instruments are reported. Some incidental findings in the use of ionization chambers in electron dosimetry are also presented. Using a variable volume, parallel-electrode chamber, experimental evidence was obtained to substantiate the Bragg–Gray cavity nature of the thimble chambers used in routine clinical dosimetry. The conversion factors obtained for a Baldwin–Farmer and Victoreen instrument show good agreement with the theoretically calculated values. The electron dose conversion factors reported by other investigators are reviewed. The availability of these dose-conversion factors puts the high-energy electron dose measurements on a par with the measurements of conventional x rays and teletherapy beams. (auth) (UK)

48568 MEDICAL RADIATION EXPOSURE SURVEY IN A HOSPITAL WITH A NUCLEAR MEDICINE LABORATORY. LeBlanc, Adrian; Johnson, Philip C. (Baylor Coll. of Medicine, Houston, Tex.). Health Phys.; 19: 433-7(Sep 1970).

The radiation exposure from nuclear medicine procedures and diagnostic procedures were compared for 100 inpatients during a single hospital admission for the years 1964 and 1968. It was found that the average gonadal dose/patient from radioisotope tests increased from 0.06 rad in 1964 to 0.14 rad in 1968, while the average total body dose increased from 0.1 rad to 0.16 rad. The estimated average gonadal exposure caused by x-ray examinations of these same individuals remained relatively unchanged at approximately 1.2 rad. Radioisotopes produced 5% of the mean gonadal exposure per admission in 1964 and 11% in 1968; however, during these years the average dose to the appropriate critical organ from some radioisotope tests actually decreased. Significant changes in the relative distribution of both nuclear medicine and x ray procedures were found. Between 1964 and 1968 the total number of radioisotope and x ray procedures performed increased 106% and 48% respectively, while the number of admissions to the hospital increased only 16%. (auth) (UK)

48569 BIOLOGICAL AND PHYSICAL DOSIMETRY AFTER A RADIATION ACCIDENT. Dolphin, G. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.); Bolton, D.; Humphreys, D. L. O.; Speight, D. L.; Stradling, G. N. Nature (London); 227: 165(11 Jul 1970).

After a radiation accident in which two industrial radiographers were accidentally exposed to 12.5 Ci of ^{60}Co, doses of 51 and 46 R γ were recorded on film badges, with an estimated exposure rate of about 20 R/hr. Dose estimates made by biological and physical methods were also compared. The biological method involved counting chromosome aberrations in cultured peripheral blood lymphocytes, and the physical method was based on a reconstruction of the accident. Reasonable agreement was obtained between the two methods, adding to the growing confidence in the use of chromosome aberration counting for dose assessment in radiation accidents. A calibration curve relating dicentric yield to radiation dose given to blood samples in vitro was also obtained for 250 kV x-rays at 100 R/min using the same culture techniques and scoring criteria. From this curve the equivalent whole body doses corresponding to the measured dicentric yields were 37 and 21 R. There were, however, important differences in the conditions of exposure as between the radiation accident and the in vitro calibration experiment, which affected the dicentric yield. The physical dose estimate made from a reconstruction of the accident involved the use of a polythene phantom containing 5m Ci of ^{60}Co. Twenty R equivalent whole body dose appears to be about the lower limit of usefulness of the biological method, because of the statistical errors associated with a limited amount of cell scoring; this scoring limitation will not be eliminated until automated chromosome aberration analysis equipment becomes available. (UK)

Radiation Protection

Refer also to abstract 48592.

48570 (BRH/DEP-70-17) RADIATION SAFETY SURVEYS OF X-RAY FACILITIES WITHIN THE FEDERAL HEALTH PROGRAMS SERVICE. [Period Covered]: March 1968-February 1969. Miller, Lois A.; Seabron, LaVert C. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Jul 1970. 39p. CFSTI.

A comprehensive survey was performed between March 1968 and February 1969 of the x-ray facilities in 11 Public Health Service hospitals and 20 outpatient clinics throughout the United States. Facility workloads, type of equipment, operator training, and equipment deficiencies were analyzed, and recommendations were made for improved training programs, equipment modifications, and continuing facility surveys at regular intervals. (auth)

48571 (BRH/DEP-70-19) RADIATION SAFETY SURVEYS OF X-RAY FACILITIES WITHIN THE BUREAU OF PRISONS DURING 1968. Seabron, LaVert C. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Jul 1970. 45p. CFSTI.

The first comprehensive survey of the x-ray facilities in the Bureau of Prisons installations throughout the United States is described. The data summarized cover visits to 27 facilities, involving a total of 60 x-ray machines. The workloads at the facilities, the type of equipment, the deficiencies noted in diagnostic radiographic x-ray machines (medical and dental), and operator training are discussed. Also included are recommendations for improving both operator and patient protection. (auth)

48572 (CEA-CONF-1561) RADIOLOGICAL PROTECTION OF THE PUBLIC. DISCUSSION OF THE PROBLEMS POSED. PRESENT SOLUTIONS. FUTURE PROSPECTS. Lacourly, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 10p. (In French). (CONF-700505-9). Dep. CFSTI (U. S. Sales Only).

From 2nd Congress of the International Radiation Protection Association, Brighton, England.

The norms established for protection of the public are expressed in terms of irradiation dose limits. The derived upper levels may be established as a function of the receptor medium or of one or more contamination-conveying foods. These levels are bound up with the environment and are only valid for the site in question. When several pollutants are present the levels should be converted into concentration limits. In most cases the radioactive pollution level is very low compared with the acceptance capacity of the receptor media, leaving a wide margin for future nuclear power plants. (auth) (France)

48573 SECOND INTERNATIONAL CONGRESS OF THE INTERNATIONAL RADIATION PROTECTION ASSOCIATION, 3-8 MAY, 1970, BRIGHTON, ENGLAND. Abstracts of Papers Presented at the Congress. Health Phys.; 19: 67-172(Jul 1970). (CONF-700505-(Abstr.)).

Abstracts of the three hundred papers presented are given under the following session titles; monitoring of workers (including whole body counting and review and use of TLD and TSEE); radiation protection policy and administration (including training); symposium on plutonium problems; release of activity into the environment; operational health physics (including accelerator problems and a review of operational experience); symposium on biological recovery from radiation damage; accidents, emergency procedures and lessons; radiation effects in man; population exposure; neutron dosimetry and radiation physics; radiation protection standards; radioecology (including natural radioactivity and fallout); experimental data (including radiobiology); instrumentation and analysis; metabolism in man; occupational medicine; dosimetry; environmental monitoring. (UK)

48574 DIFFERENTIATED ANTIRADIATION PROTECTION OF THE ORGANISM OF PATIENTS WITH TUMORS. Yarmonenko, S. P. Med. Radiol.; 15: No. 4, 16-22(Apr 1970). (In Russian).

The current state, difficulties and prospects of prevalent weakening of critical organs and the whole organism by irradiation in the process of radium therapy of malignant neoplasms are discussed. The ways of experimental alleviation of the problem with the aid of physical factors (local hypothermia and anoxia) and chemical radioprotectors are outlined. The practical aspects of increasing the radiosensitivity of the organism in a radiological clinic are analyzed. In particular, subject to discussion are clinical situations during which it is desirable to employ certain methods of local or whole-body radiation protection of patients with tumors. (auth)

Safety Procedures

Refer also to abstract 48716.

48575 (CONF-690441) SOUTHERN AREA RESEARCH AND DEVELOPMENT SAFETY SYMPOSIUM, OAK RIDGE, TENNESSEE, APRIL 28-29, 1969. (Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.). 160p. Dep. CFSTI.

These proceedings contain eleven papers dealing with the following topics: combating laboratory fires; industrial hygiene in a research oriented facility; the safety environment at the ZGS complex; engineering for hospital safety; engineering design as a safety control for advanced research projects; determination of flammability and explosive limits; safety in AEC research and development activities; high energy storage systems' safety in research and development; safe handling of fluorine; handling and use of cryogenics; and unusual and unexpected radiation sources. (E.R.B.)

48576 (ORNL-4563) APPLIED HEALTH PHYSICS AND SAFETY ANNUAL REPORT FOR 1969. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 68p. Dep. CFSTI.

There were no accidental releases of gaseous or liquid waste from the Laboratory that were of a reportable level as defined in AEC Manual Chapter 0524. The concentration of radioactive materials in the environs was well below the maximum levels recommended by the ICRP, FRC, and AEC. No employee received an external or internal radiation dose of a level that required a report to the AEC. The highest whole-body dose received by an employee was about 3.8 rem or 32% of the maximum permissible annual dose. There were no cases of internal exposure where the deposition of radioactive materials within the body was estimated to have averaged greater than one-half of a maximum permissible body burden. There were 12 unusual occurrences recorded during 1969, which is the lowest number recorded since the present system of reporting unusual occurrences was established in 1960. The second lowest number for any one year was 16, the number reported for 1967. The average number reported for the past five years was 22. The ORNL safety record for 1969 was the second best in the history of the Laboratory. There were only two disabling injuries reported during the year, and there was a decrease in number of both serious injuries and medical treatment cases as compared with 1968. The disabling injury frequency rate for 1969 was 0.27, as compared with the average rate of 0.94 for the previous five years, 1964 to 1968. (auth)

48577 LEUKOPOIESIS IN LEUKOPENIA IN PERSONS EXPOSED TO SMALL DOSES OF IONIZING RADIATION. Sokolov, V. V.; Gribova, I. A.; Akhundov, P. F.; Gorizontova, M. N.; Tolcheva, E. I. Gig. Tr. Prof. Zabol.; 13: 42-4(Nov 1969). (In Russian).

The results following hematological examination of 85 persons with moderate leukopenia are presented. All these persons were occupationally exposed to small doses of ionizing radiation. Findings subsequent to morphological investigations of the bone marrow punctates demonstrate that quantitative derangements in the production of cells are of no essential importance in these instances. Of greater significance is the production resulting from an intensive regeneration of functionally substandard cells, this being borne out by cytochemical changes of cellular elements in the bone marrow and the peripheral blood, by the changes in their size, and also by a lower phagocytic activity and osmotic resistance of granulocytes. (auth)

48578 ADRENAL FUNCTION IN SOME OCCUPATIONAL DISEASES. Ozerova, V. V.; Savvaitova, N. I.; Gorbarenko, N. I.; Strygina, T. A. Gig. Tr. Prof. Zabol.; 13: 39-42(Nov 1969). (In Russian).

Spontaneous excretion of corticosteroid urinary metabolites was investigated in 183 persons, in 41 patients with chronic berylliosis, in 84 suffering from silicosis and silico-tuberculosis, in 27 with chronic radiation sickness and in 31 healthy subjects. Examinations disclosed dysfunction of the suprarenals in all of the sick persons translated by a different degree of the functional reserves decline with unchanged spontaneous excretion of corticosteroids. The extent of the diminished functional reserves did not depend distinctly on the intensity of the primary effect. The similarity of the functional condition of the adrenal glands in patients with different diseases presented proof to the nonspecificity of the organism's response mediated through the hypophysis-adrenal system in response to the action of various pathogenic agents. (auth)

48579 WHAT YOU SHOULD KNOW ABOUT RADIATION HAZARDS. Rummerfield, Philip S. (Univ. of California, San

Diego); Rummerfield, Marilyn J. Amer. J. Nursing; 70: 780-6(Apr 1970).

Basic information on the biological effects of ionizing radiations is reviewed for the guidance of hospital nurses who may be exposed to radiations emitted from x ray machines or radioisotopes. General guidelines are outlined for radiation protection practices for nurses handling patients following the administration of radioisotopes or the implantation of γ sources for therapy. (C.H.)

48580 CURRENT STATUS OF LASER THRESHOLD GUIDES. Powell, Charles H. (Bureau of Occupational Safety and Health, Cincinnati); Bell, Herbert E.; Rose, Vernon E.; Goldman, Leon; Wilkinson, Thomas K. Amer. Ind. Hyg. Ass. J.; 31: 485-91(Jul-Aug 1970).

The rapidly expanding use of lasers in industry, medicine, and research since the development of the first laser in the 1950's has been paced by a growing concern in governmental, industrial, and environmental health organizations of the health hazards associated with the operation and use of these devices. This interest has been intensified by a swelling public interest and controlling legislation at both the state and federal levels. Fragmentary and incomplete exposure data precluded the development of any exposure guidelines until the last several years. The first criteria were proposed for the military services in 1967. These Tentative Guides, based on the eye as the critical organ, use retinal burn as the criterion for evaluation of the time/dose relationship. A review of these criteria is presented. (auth)

Civil Defense

Refer also to abstract 48398.

48581 ECOLOGICAL APPROACH TO EVALUATION OF LOCAL HEALTH DEPARTMENT PREPAREDNESS TO COPE WITH DISASTER (WITH SPECIAL REFERENCE TO THERMONUCLEAR ATTACK) AND A PROPOSED INSTRUMENT FOR PREPAREDNESS ASSESSMENT. Salmon, Raphael Jack. College Park, Md.; Univ. of Maryland (1969). 452p.

Thesis.

Health departments play an important role in development of community/state emergency planning and action programs. Their effectiveness is determined, at least in part, by staff limitations. Some aspects of the hypothesis that public health personnel presently employed by local health departments have only limited understanding of the types of public health problems that may be anticipated following a community and/or national disaster such as thermonuclear attack are explored. The methodology developed began with thorough analysis of available source materials and case studies pertaining to public health problems and the response of public health personnel to previously experienced natural and man-made disasters. The appraisal clearly revealed that, although in many instances extensive reporting was done on specific events, there has been little attempt to approach emergency public health problems from the necessary wholistic viewpoint. Based on this systematic literature analysis, as well as fieldwork and other efforts previously conducted under a contract with the U. S. Public Health Service, an analytical framework for assessment of community health needs was developed and applied. Attention was given to water supplies, food, housing, sewage, and refuse disposal, as well as psychological and social responses. A set of indicators that may be used to project some basic community problems expected to affect population health conditions following thermonuclear attack was developed. Patterns of community resources and services relating to specific public health problems were identified. Utilizing the framework and indicators formulated, as well as appraisal of present public health organization and training patterns, a survey instrument focusing on water supply problems was prepared to test personnel preparedness. Assessment was made of some key elements that should be considered in development of research design to provide a methodology for a sample survey of local health departments in the continental United States. After preliminary field testing in six selected communities, the survey instrument was applied in its final form in the local health department of a community with a population of about 500,000. The survey instrument developed proved to be an effective means of appraising the preparedness of local health department personnel to cope with postattack health problems. It also provided a useful framework for communication relative to the level of agency and staff. Coupled with the previous literature analysis and field observations, this study confirmed the hypothesis originally made, i.e., that public health personnel in local health departments are likely to be poorly prepared to cope with anticipated health problems following a disaster such as thermonuclear attack. The study pointed to some specific limitations in terms of disciplinary training, functioning, and administrative responsibilities of selected staff members of the health departments concerned. Scarcity of personnel in peacetime and inadequacies in training and experience may be expected to be accentuated under the constraints of a postattack situation. Administrative structure and managerial responsibilities may further handicap preparedness efforts and subsequent responses. Public health preparedness constitutes a process in its truest sense. It is highly dependent upon effective health education and community involvement programs of both professional and lay members of the community. On the basis of study findings, specific recommendations for training, planning, research, and demonstrations relative to emergency health programs were made. This investigation re-emphasized the need for development and operation of a process of education, investigation, and action tied not only to hypothetical conditions, but also to the pre-disaster environment. The kind of appraisal that was undertaken may provide the necessary first step in efforts to develop meaningful educational health preparedness programs. (Diss. Abstr. Int., B)

Legal Aspects

Refer also to abstract 48775.

48582 (CONF-700810-33) THE UNITED KINGDOM APPROACH TO THE APPLICATION OF ICRP STANDARDS TO THE CONTROLLED DISPOSAL OF RADIOACTIVE WASTE RESULTING FROM NUCLEAR POWER PROGRAMMES. Preston, A. (Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Fisheries Radiobiological Lab.). [1969]. 14p. (SM-146/9). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

United Kingdom policy for the routine control of radioactive effluents originating from a nuclear power program is outlined, and, using specific examples, it is shown how the ICRP recommended standards are applied to the controlled release of radioactive waste material to the environment. It is shown that the practical application of basic dose criteria to diverse environmental situations necessitates a quantitative evaluation of the possible exposure pathways in each situation, and in some cases the identification of a critical population group, before recommended limits expressed in terms of dose can be applied. Final authorizations for waste disposal, while always subject to the absolute limitations of safety, are also carefully related to justifiable operational needs. (auth)

48583 RADIATION SAFETY NORMS (NRB-69). Dibobes, I. K.; Knyazev, V. A.; Moiseev, A. A.; Moskalev, Yu. I.; Sivintsev, Yu. V.; Teverovskii, E. N.; Terman, A. V.; Shamov, V. P. At. Energ. (USSR); 28: 463-7(Jun 1970). (In Russian).

The radiation tolerances accept the concept of justifiable risk, which is defined as a risk less than or equal to the risk associated with the harmful effects of non-radioactive, industrial sources. The risk must be justified by the utility of radioactive sources. The allowable dose does not include the background dose or the dose received by patients in the course of medical treatment. People are divided into three catagories: (A) individuals; (B) groups of people working with or living near radioactive sources; and (C) the population as a whole in estimating the radiation dose that would be of genetic significance. The maximum allowable internal and external radiation doses to individuals are as follows: 5 biological equivalent rads (ber)/yr to the whole body, gonads, and bone marrow, 15 ber/yr to the muscles, fatty tissues, liver, kidney, spleen, lungs, eyes, and other body organs, 30 ber/yr to the bone, thyroid, and skin, and 75 ber/yr to the hands, forearms, and legs. The above doses are reduced by a factor of 10 for people in category B. The limiting dose to the thyroid gland of children under 16 is 1.5 ber/yr. Individuals who may obtain 30% of the annual dose are subjected to dosimetric control and medical observation. A whole-body dose of 25 ber is considered potentially dangerous with medical observation being called for. The concept of a maximum allowable concentration of an activity is replaced by the concept of an average-annual allowable concentration of activity. For most isotopes the average-annual concentration is a factor of three greater than the maximum allowable concentration, but is a factor of 10 greater for a number of isotopes such as ^{89}Sr and ^{137}Cs. The genetic dose to the population as a whole should not exceed 5 ber over 30 years. A total of 10 to 15% of this allowable genetic dose was incurred from radioactive fallout as a result of nuclear testing. (TTT)

Medicine

Protective Substances

Refer also to abstracts 48406, 48512, and 48746.

48584 HEMOPOIETIC STEM-CELL NUMBER AND RADIOSENSITIVITY: RADIOPROTECTION WITH PHENYLHYDRAZINE. Smith, L. H. (Oak Ridge National Lab., Tenn.). Trans. N. Y. Acad. Sci.; 32: 448-52(Apr 1970).

Using 30-day survival as an end point, the radioprotective effect of phenylhydrazine (PHCl) was tested in x-irradiated mice. The data for this drug show that the $LD_{50(30)}$ is increased from 750 R to 880 R; maximum protection is achieved when mice are injected about one week before irradiation; injection immediately before or after irradiation is not protective; a single injection is as effective as multiple injections; all injection routes are effective; protection is not limited to one type of hybrid mouse; and survival is a function of PHCl dose. The hypothesis that survival from lethal x-irradiation relates to the number of hemopoietic stem cells present at the time of exposure was considered in terms of the radioprotective effect of phenylhydrazine. (auth)

48585 MODIFICATION OF EFFECTS OF PROTON AND GAMMA RADIATION ON THE RECTAL MUCOUS MEMBRANE BY LOCAL HYPOXIA. Stenson, Stig (Uppsala Univ. Umea Univ., Sweden). Acta Radiol., Ther., Phys., Biol.; 9: 115-28 (Apr 1970).

Rectal injection of norepinephrine and sodium sulfite during irradiation of the abdomen of the rat with cobalt γ rays or high-energy protons was found to partially reduce the severe histologic damage of the rectal mucous membrane that is usually seen after irradiation of this structure. The protective effect was ascribed to the hypoxic state in the rectal wall induced by the treatment. (auth) (Sweden)

48586 CHARACTERISTICS OF REPAIR SYNTHESIS IN X-IRRADIATED P388F LYMPHOMA CELLS. Fox, Margaret; Ayad, S. R.; Fox, B. W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 18: 101-10 (1970).

Preparative CsCl density-gradient centrifugation was used to demonstrate repair synthesis in P388F cells after 300 rads x rays. Repair synthesis was stimulated two-fold when cells were grown in 5-iodo-2-deoxyuridine before irradiation. A time course was determined by autoradiography and after DNA isolation in cultures treated with hydroxyrea (HU) to inhibit normal DNA synthesis. The rate of HU-insensitive DNA synthesis in irradiated cultures was found to exceed that in control cultures by a factor of two from 0 to 60 min after irradiation. Autoradiographic studies have shown that the radiation stimulated thymidine incorporation is restricted to S cells. (auth) (UK)

48587 INFLUENCE OF POST-IRRADIATION CONDITIONS ON THE SURVIVAL OF CHINESE HAMSTER CELLS AFTER GAMMA-IRRADIATION. Arlett, C. F. (Atomic Energy Research Establishment, Wantage, Eng.). Int. J. Radiat. Biol.; 17: 515-26(1970).

Chinese hamster cells were exposed to a variety of treatments after γ irradiation. When DNA or protein synthesis was inhibited, there was no effect on survival. There was also no effect on survival from a reduction of temperature or the addition of caffeine. Actinomycin D, acriflavine, and ethidium bromide, which have the property of binding to nucleic acids, brought about a reduction in survival. It is suggested that the activity of any enzymes that repair radiation lesions in nucleic acids is impeded in a steric manner by the resulting complexes. (auth) (UK)

48588 RADIOPOTENTIATING ACTION OF 1-β-D-ARABINOFURANOSYLCYTOSINE IN A XENOGRAFTED HUMAN COLONIC CARCINOMA. Goldenberg, David M. (Univ. of Pittsburgh. Veterans Administration Hospital, Pittsburgh). Proc. Soc. Exp. Biol. Med.; 134: 510-12(Jun 1970).

Low, nontumoricidal, single daily doses of ara-C had radiopotentiating effects when combined with 300 R x rays in the GW-39 human colonic carcinoma growing in the cheek pouch of unconditioned golden hamsters. At the same total dosage (12 mg/kg day), a divided daily dose schedule of ara-C proved more effective both when administered alone and in combination with x radiation. (auth)

48589 A DISCUSSION OF THE OXYGEN EFFECT BASED UPON THE TWO-COMPONENT THEORY OF RADIATION. Wideroe, R. Radiol. Clin. Biol.; 39: No. 1, 20-31(1970).

Various experimental findings concerning the effect of oxygen on the radiosensitivity of cells are discussed in terms of the 2-component theory of radiation. Oxygen concentration mainly affects the β-effect which is reduced to zero at complete anoxia. Here, the different results so far obtained can easily be explained. Regarding the α-effect, however, the findings are controversial and further experiments are needed to clarify the situation. Recent measurements suggest even that recovery effects on α-damaged cells may be possible at small oxygen concentrations. The difference between the extrapolation number p and apparent extrapolation numbers that are found by means of tangents drawn to the survival curve at arbitrary points is explained. (auth)

48590 IS RADIOSENSITIZATION OF TUMOUR CELLS BY N-ETHYLMALEIMIDE CAUSED BY ITS ABILITY TO BIND THE NON-PROTEIN -SH GROUPS IN THE CELLS. Klimek, M.; Zemanova, L. (Inst. of Biophysics, Brno). Neoplasma; 17: 209-12(1970).

A method is described for determining non-protein SH groups in HeLa S3 cells. After exposure to 2 μM solution of NEM, only 6.7% free thiol groups were bound. The free thiol groups were nearly completely bound only at concentrations higher than 50 μM. It was found that after a dose of 150 R the content of free SH groups in cells was equal to 75% of the original content of free thiol groups in non-irradiated HeLa cells. At a dose of 300 R still more than 60% of the original content of free thiol groups were present. It was concluded that the binding of free SH groups in NEM at a concentration of 2 μM was not the only cause of the observed radiosensitization effect, since the concentration of free thiol groups remained in the irradiated cells high enough to justify the assumption that the repair of the DNA molecules damaged by radiation is not hindered by lack of hydrogen donors represented by non-protein SH groups. (H.L.W.)

48591 CLINICAL APPLICATION OF RADIOSENSITIZERS, HALOGENATED PYRIMIDINES TO HEAD AND NECK TUMORS. Tanaka, Yoshimasa; Takahashi, Masaharu (Tenri Hospital, Nara, Japan). Jap. J. Clin. Radiol.; 14: 765-75(Oct 1969). (In Japanese).

To 36 cases of advanced head and neck tumor (T_3 or T_4 stage), the combined therapy of intraarterial infusion of halogenated pyrimidines with irradiation was tried. The results obtained were as follows. The incorporation of radiosensitizers into tumoral and normal tissues was studied, using Ehrlich's ascites tumor transplanted subcutaneously on the back of dd-strain mice. ^{125}I incorporation into tumor and spleen in combined administration of 20 μCi 2'-deoxy-5-iodouridine of ($^{125}IUdR$) with 5-fluorouracil (5-FU) (3mg), was about 6 times and about 3 times, respectively, as much as that in the case of administering $^{125}IUdR$ alone. In clinical application, 11 cases were given 5-FU alone with a daily dose of 500 mg, and 25 cases were administered 250mg/day of 5-bromo-2'-deoxyuridine (BUdR) and 5-FU (50mg/day) in combination, and irradiation to both groups was carried out with 6 MeV Linac by a daily dose of 100 R to 150 R up to a total of 7000 R. The damage to oral mucosa in the combined use of BUdR with 5-FU was slighter and recovery was quicker than that in the administration of 5-FU alone. Cases to which the sufficient dose of radiosensitizers could be given without causing any severe side effect were 5 of 11 (45.5%) in 5-FU alone, and 17 of 25 (68.0%) in combined use. Cases in which the effect of radiosensitizers was ascertained, were 7 of 11 (63.7%) in 5-FU alone, and 21 of 25 (84.0%) in combined use. (NSA of Japan)

48592 N-SUBSTITUTED AMINOETHANETHIOLS AND N-SUBSTITUTED AMINOETHANETHIOL S-SULFONIC ACIDS AS RADIOPROTECTIVE AGENTS. Carroll, F. I.; Monroe, E. Wall. J. Pharm. Sci.; 59: 1350-2(Sep 1970).

Several N-substituted aminoethanethiols and N-substituted aminoethanethiol S-sulfonic acids were tested as potential radioprotective agents. 2-(2'-Carbamidoethylamino)-ethanethiol (Ia). 2-(2'-carboxyethylamino)-ethanethiol (Ib), 2-(2'-cyanoethylamino)-ethanethiol (Ic), and 2-(2'-carbamidoethylamino)-ethanethiol S-sulfonic acid (IIa) exhibited significant protective effects against ionizing radiation. Compound Ia showed the highest activity and was selected for further radiation-protection test studies. The structure activity relationships of this class of compounds are discussed. (auth)

Radiation Sickness and Injuries

Refer also to abstracts 48686, and 48753.

48593 REPAIR OF MAMMALIAN CELL DNA: EFFECTS OF DRUGS AND MUTATIONS. Cleaver, J. E. (Univ. of California, San Francisco). Ann. Ist. Super. Sanita; 5: 360-8(1969).

From Photobiology Meeting, Rome, Italy. See CONF-690552.

In order to determine the role of repair replication in mammalian cells, the process of DNA repair was studied using two approaches: a study of the effects of drugs added after irradiation; and a study of repair replication in hereditary human skin diseases. The characteristics of repair replication in mammalian cells are listed. The effects of three groups of drugs (those

limiting the supply of DNA precursors, those binding to DNA, and those with miscellaneous modes of action) on repair replication was determined in uv damaged HeLa cells. Of several human skin diseases studied, Xeroderma pigmentosum cells were the only cells that could not repair damage to DNA bases following uv irradiation. The significance or importance of repair replication in mammalian cells is discussed briefly. (E.R.B.)

48594 INFLUENCE OF METABOLIC INHIBITORS ON THE RESPONSE OF CHINESE HAMSTER CELLS TO ULTRA-VIOLET LIGHT. Arlett, C. F. (Atomic Energy Research Establishment, Wantage, Eng.). Ann. Ist. Super. Sanita; 5: 367-75(1969). From Photobiology Meeting, Rome, Italy. See CONF-690552.

Information on the response of Chinese hamster cells (CHC) to changes in the post-irradiation environment following treatment with uv radiation is provided. Of the compounds tested that bind to nucleic acid, acriflavine and actinomycin D had no effect without also being toxic to the cells. Ethidium bromide increased survival when added at low doses (1 to 10 μg/ml) and reduced survival when added at high doses (50 μg/ml). The response of asynchronous and synchronous populations of CHC to inhibitors of DNA synthesis following uv irradiation was negative at nontoxic doses. The compounds tested were thymidine, hydroxylamine, and cytosine arabinoside. Repair replication and normal DNA synthesis (semi-conservative replication) differ in their mechanism of action, this may explain the negative effects of the inhibitory compounds. (E.R.B.)

48595 CONDITION OF THE NERVE SUTURE DEPENDING UPON SUTURING MATERIALS IN COMBINED NERVE TRUNK INJURY. Demchuk, A. I. Vrach. Delo; 5: 90-2(1968). (In Russian).

Experiments on rabbits indicate that in conditions of radiation lesions catgut proved the most inappropriate suture material for neurorrhaphy. Neurorrhaphy with silk resulted in smoother nerve regeneration in these conditions. (auth)

48596 HEMATOLOGIC AND RADIO-ISOTOPIC STUDY OF PRIMARY HEMOSIDEROSIS. Freour, P.; Blanquet, P.; Leger, H.; Ferret-Bouin, P.; Chomy, P.; Bernadou, J.; Ducassou, P.; Nicolas, F. J. Fr. Med. Chir. Thorac.; 22: 213-26(Feb-Mar 1968). (In French).

A primary pulmonary hemosiderosis was followed in a young girl for 3.5 yrs. The main features were an initial hemoptysis and flare up following an intercurrent disease (toxoplasmosis). As no side siderocyte could be detected, lung biopsy was carried out, and the condition was then confirmed. Hematology, serology, and ^{51}Cr and ^{59}Fe made it clear before the histological study of the specimen. (auth)

48597 CLINICO-PHYSIOLOGIC METHODS OF STUDYING THE ASTHENIC SYNDROME IN PERSONS COMING INTO CONTACT WITH IONIZING RADIATION. Glazunov, I. S.; Blagoveshchenskaya, V. V.; Martynova, G. N. Zh. Nevropatol. Psikhiat.; 69: 567-73(1969). (In Russian).

On the basis of clinico-physiological studies and long-term observations of patients during several years, diagnostic questions of the asthenical syndrome of radiation etiology are discussed. Among the applied techniques, the following methods were used: the determination of the function of taste, olfactorial, tactile, and vibrational analyzers as well as their interaction. Besides that, the memory in such patients, cortical neurodynamics according to the speech motor method of Ivanov-Smolensky, and the state of the second signal system (Piotichers modification), were also studied. (auth)

48598 CASE OF ACUTE RADIATION SICKNESS IN MAN. I. Gembitskii, E. V.; Kolesnik, F. A.; Ventsenostsev, B. B. Med. Radiol.; 15: No. 8, 48-54(Aug 1970). (In Russian).

A case of radiation injury in man occurring as the result of extremely nonuniform γ irradiation, with the most intensive effect of radiation on the left iliac region is described. Special attention is drawn to the dynamics of local radiation injury and complications thereof. In the clinical picture of the injury, the following prevailed: a severe burn of the left iliac region with involvement of the abdominal wall and underlying intestinal lesions. In three months these changes led to stenosis of the sigmoid and manifestations of intestinal obstruction, due to which it became necessary to establish an unnatural anus. The postoperative period ran a course without severe complications, however general metabolic and trophic disorders disappeared very slowly; reparative processes in the focus of the local radiation lesion were weakly pronounced. The treatment is depicted. (auth)

48599 VETERINARY TREATMENT: HOW IS IT DONE? Il'in, V.; Obuvaylo, P. Voen, Znaniya; No. 11, 42-3(Nov 1969). (In Russian).

Veterinary treatment of cattle exposed to radioactive substances, poison gases, or biological agents is conducted to prevent or lessen the possibility of the animals becoming sick, permit them to be used as intended, make contact with them safe, and, in the case of biological agents, prevent the infection from spreading. Veterinary treatment may be done by the wet, dry, or combined methods depending on the type of weapon used, the manpower and facilities available, and the local meteorological conditions and time of year. (auth)

Radiodiagnosis

Refer also to abstracts 48261, 48266, 48267, 48357, 48363, 48568, 48570, 48571, 48721, 48730, and 48731.

48600 (BNWL-1307(Pt.2), pp 45-9) NUCLEAR TECHNIQUES IN MEDICAL SCIENCE. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

The purpose of this study is to perform research in the application of nuclear technology and radioisotopes to the fields of medicine and biology and to combine the advanced knowledge, techniques, and instrumentation of the nuclear field with the talent and knowledge of the medical profession to improve and increase the direct medical benefits to mankind. (auth)

48601 CURRENT DEVELOPMENTS IN ISOTOPE DIAGNOSIS. Kooman, A. Ned. Tijdschr. Geneesk.; 113: 1820-4(Oct 1969). (In Dutch).

Developments in isotope diagnosis during the last 5 yrs included the improvement of linear scanners, based on the use of large crystals and of up to ten crystals simultaneously. Multiple static crystals were installed in a γ-ray camera. Reduction of exposure times made it possible to study isotope dynamics; the isotope distribution was determined by means of computer calculations. Activation of stable iodine by ^{241}Am from an external source allows monitoring in fluorescent thyroid scanning studies; the collimator and the detector have the thyroid itself as the common focal point. Absence of residual radiation after exposure allows for halving of the dose. The exposure of patients to radiation may also be reduced by the employment of short-lived isotopes, such as ^{99m}Tc which may be produced locally by means of a molybdenum generator. Technetium-albumin aggregates of varying sizes are used to trace lung embolism. Technetium colloids and technetium-iron complexes were found useful for liver and kidney scans, respectively. Other useful short-lived generator-produced isotopes include ^{113m}In to localize the placenta and ^{87m}Sr used for bone scans. Circulation in the legs may be studied by determining the time of arrival in the feet of radioalbumin injected in the vena cubiti; the rapid arterial transfer and the slower transfer via the smaller vessels may be evaluated by examining the two-component arrival curves. (TTT)

48602 REPORT OF THE WORKING PARTY ON THE ORGANISATION OF RADIOACTIVE ISOTOPE SERVICES. London; Her Majesty's Stationery Office (1970). 20p. 2s. 6d.

The report of a working party set up to consider the development and organization of work involving the use of radioactive isotopes in the National Health Service and to make recommendations is presented. The working party was convened due to the absence of any generally accepted guidelines in the organization of this developing area of medicine. The report is presented under the headings: introduction, coordinated planning of radioisotope services, the radioisotope services of the future, organization within hospitals, regional radioisotope centers, services in the district general hospitals and the smaller hospitals, staff training, purchase and distribution of radioisotopes. (UK)

48603 THRESHOLD DETECTION TESTS IN RADIOISOTOPE SCANNING. Sharma, R. R. (Postgraduate Inst. of Medical Education and Research, Chandigarh, India); Fowler, J. F. Phys. Med. Biol.; 15: 289-300(Apr 1970).

Statistical tests used by various authors have yielded dissimilar values of statistical index n for the threshold detection of small abnormalities in radioisotope concentrations (n = 2.5 to 3 by Dewey and Sinclair, Matthews and others, as compared with n = 5 to 6.5 by Rose and Vernon). This paper explains the relationship between these two types of statistical tests. The optimum size of the test area relative to the resolution diameter (FWHH) of a scanning device is derived, and is found to correspond to an isocontour of 25% to 30%, normalized to 100% at the central peak of the point source distribution. Experiments were carried out in which observers recorded the threshold detection of spherical sources in radioactive tanks. Two categories of discrimination were necessary: only definite and all possible. The statistical indices required to give correct detection in 95% of 20 pictures

scored by 16 observers were n = 5 and 4 respectively for the two categories. (auth) (UK)

48604 SIGNIFICANCE OF ISOTOPE NEPHROGRAM IN PEDIATRIC DIAGNOSIS OF THE RENAL FUNCTION IN COMPARISON WITH THE VALUES OF CLEARANCE BY PROLONGED INFUSION. Devaux, S.; Grossmann, P.; Altenbrunn, H.-J.; Zoellner, K.-D. (Univ. Charite, Berlin). Radiol. Diagn.; 11: 117-21(1970). (In German).

Results are interpreted in such a way that the elimination of ^{131}I Hippuran in the concentrations used is practically complete during a renal passage of the test-substance even in damaged tubular function so that a high dependence of ^{131}I Hippuran excretion on blood circulation within the kidney is assumed. It is concluded that the renal flow of plasma and renal blood circulation, respectively that were derived from the E-value of the isotope nephrograms are accurate enough for clinical purposes. The possibility to determine lateral differences in the renal function seems especially advantageous. (auth)

48605 OCHERKI MEDITSINSKOI RADIOLOGII. (Works on Medical Radiology). Zavadovskii, D. K. Tomsk, USSR; Izdatel'stvo Tomskogo Universiteta (1969). 328p.

A brief review is given on the history of medical radiology. Various chapters are devoted to dosimetric control, biological ionizing radiation effects, radiation protection, diagnostics, and therapy. Special attention is given to the radiation injuries resulting from uncontrolled exposure to ionizing radiation and specific radiation complications resulting in certain cases during radiation therapeutic treatments. (R.V.J.)

48606 DETERMINATION OF THE LOCAL PLACENTAL BLOOD FLOW IN PREGNANT WOMAN USING ^{133}Xe. Josserand, P.; Farre, J.; Aragon, B. Onde Elec.; 50: 438-44(May 1970). (In French).

The use of ^{133}Xe for the measurement of blood flow is becoming more widespread. Its application to the measurement of placental blood flow during pregnancy is examined from both a theoretical and a practical viewpoint. Automatic bloodflow readout systems for making hemodynamic measurements are proposed. Such systems could be put into general use outside obstetrics. (auth) (France)

48607 DETECTION OF BONE LESIONS BY PHOTOSCANNING WITH ^{87m}Sr. Malamos, B.; Kostamis, P.; Constantinides, C. (Univ. of Athens). Atomkernenergie; 15: 167-8(1970).

The availability of short-lived radionuclides allows an increase of diagnostic scintigraphic procedures. Because of the low radiation dose and the good affinity of the ^{87m}Sr for bones it was used for visualization and detection of different bone diseases. Scintigraphic results of 150 patients are analyzed and discussed. (auth)

48608 MINIMAL CARDIAC TRANSIT TIMES IN HEALTHY PERSONS AND THOSE WITH HEART DISEASE: INVESTIGATIONS WITH ^{113m}In AND THE GAMMA-RETINA. Schicha, H. (Kernforschungsanlage, Juelich, Ger.); Vyska, K.; Becker, V.; Seipel, L.; Feinendegen, L. E. Atomkernenergie; 15: 150-6 (1970). (In German).

Minimal transit times (MTTs) in 50 normal persons and 50 patients with various proven heart defects were measured by means of the Gamma-Retina after injection of ^{113m}In DTPA. The whole-body radiation dose in these investigations was about 4.5 to 7.0 mrad. The MTTs were obtained out of single time-activity curves, which were registered over different areas of the heart. Minimal transit times of healthy persons showed a small standard deviation, if heart frequency was considered. A high degree of reproducibility was found for any repeatedly examined person. The total transit time from the right auricle to the aorta, corrected to a pulse rate of 80/min had a mean of 6.7 sec., with a standard error of ±0.45%. The corresponding standard deviation was 3.1%. While the average of the MTTs from the auricles to the ventricles and then either to the pulmonary artery or the aorta was about 0.8 sec., the average of the MTT from the pulmonary artery to the left auricle was 3.3 sec. Patients with valvular defects showed a significant correlation of specific changes of MTTs for single heart segments with the kind of heart lesion. Changes of minimal transit times resulting from administration of digitalis were also demonstrated in patients with heart insufficiency. The described technique of measuring MTTs is suitable for clinical routine diagnosis, because of the comparative lack of stressful demands on the patient, the simplicity of the technology, and the rapidity of the evaluation. (auth)

48609 CURRENT RESEARCH IN NUCLEAR MEDICINE. Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 669-75(Aug 1970).

Recent developments in the field of nuclear medicine are reviewed and the effectiveness of radioisotope scanning for the clinical evaluation of patients with a variety of disease conditions is discussed. Emphasis is placed on brain scanning for tumor localization using ^{99m}Tc-pertechnetate; tomographic studies using a γ camera and rotating collimators and cisternography using ^{169}Yb-DTPA for studies of cerebral vascular and neurologic disorders; bone marrow scanning using ^{198}Au colloid, ^{99m}Tc-sulfur colloid, ^{68}Ga-ferric oxide, or ^{113m}In-ferric hydroxide for the location of functional activity; the use of microspheres labeled with ^{99m}Tc or ^{113m}In for measurements of blood circulation in bone, marrow, liver, spleen, and the serial evaluation of patients with pulmonary embolic disease and measurements of transpulmonary shunting; and the use of ^{99m}Tc-pertechnetate, injected as a bolus, for angiography in patients with circulatory disease. New in vitro tests include the automated detection of bacterial growth in blood cultures based on the incubation of cultures in liquid media with ^{14}C-glucose the only carbohydrate source and measurement of $^{14}CO_2$ produced. (C.H.)

48610 SCINTIANGIOGRAPHY OF CEREBRAL ARTERIOVENOUS MALFORMATIONS AND ANEURYSMS. Binet, Eugene F.; Loken, Merle K. (Univ. of Minnesota, Minneapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 707-13(Aug 1970).

Six patients with intracerebral arteriovenous malformations or large aneurysms were studied by both cerebral angiography and rapid sequential serial scintiphotography employing ^{99m}Tc and a scintillation (Anger) camera. In addition, computer analysis of the scintiphotographic studies depicted both the location and character of the vascular lesions. Computer analysis of the radioisotope serves to quantitate the amount of isotope passing through the vascular lesion as compared to the normal brain. In several cases, the computer analyses yielded information not obtained from the cerebral angiographic studies. (auth)

48611 SERIAL BRAIN SCANNING WITH RADIOACTIVE XENON AND SCINTILLATION CAMERA. Handa, Jyoji; Handa, Hajime; Torizuka, Kanji; Hamamoto, Ken; Kousaka, Tadako (Kyoto Univ. Kyoto Hospital). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 701-6(Aug 1970).

Using a gamma ray scintillation camera, serial scintiphotography of the brain was obtained during and after intracarotid injection of ^{133}Xe dissolved in saline. The perfusion pattern of three major cerebral arteries was visualized and its abnormality was detected but the circulation of the second-order branch could not be assessed. Pathologic radioxenon brain scans were divided into two types. In the lesion with a rich vascularity and high blood flow, the initial scintiphotograph during the injection period demonstrated high radioactivity in the focus which disappeared rapidly only to leave the cold focus in the later scintiphotographs. Occasionally, the distribution of radioactivity appeared homogeneous in the initial period, but later the pathologic focus rapidly became cold. In the lesion which was poor in blood pool and blood flow, the focus was cold in the initial scintiphotograph and the washout was invariably slow. The technique does not seem to replace other neuroradiologic diagnostic methods; however, it often provides a useful visual image of the avascular lesion, particularly when angiography or conventional brain scanning fails to reveal the focus. (auth)

48612 RADIONUCLIDE IMAGING IN THE DETECTION AND DIFFERENTIAL DIAGNOSIS OF CRANIOPHARYNGIOMAS. James, A. Everette Jr.; DeLand, Frank H.; Hodges III, Fred J.; Wagner, Henry N. Jr.; North, Wendy A. (Johns Hopkins Medical Institutions, Baltimore). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 692-700(Aug 1970).

Craniopharyngiomas are uncommon, benign, sellar or suprasellar neoplasms of congenital origin. The brain scan pattern in craniopharyngioma consists of an abnormal accumulation of radioactivity arising from the sellar region and extending superiorly. This lesion will be more often detected by multiple views. When the brain scan is analyzed concomitantly with skull roentgenograms, other diagnostic possibilities can usually be eliminated. (auth)

48613 PLACENTAL IMAGING WITH ^{113m}In. Mishkin, Fred S.; Carter, James E.; Reese, Isaac C. (Indiana Univ., Indianapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 776-9(Aug 1970).

Indium-113m can be simply and rapidly prepared so that it binds to serum transferrin upon intravenous injection for use as a placental imaging agent. Its desirable biologic and physical properties allow administration of multimillicurie amounts which yield clearer and better definition of the uterus, placenta, and normal surrounding vascular structures than possible with previously used agents. The relationship of these normal anatomic

structures provides reliable information for interpreting the relationship of the placenta to the uterine os. Use of the gamma camera shortens the time required for one view to about 5 to 6 minutes. Interpretation of the images is usually simple and by means of multiple views has proven accurate in 95% of the cases studied. (auth)

48614 COMPREHENSIVE EVALUATION OF RADIOLOGIC EXPLORATION OF THE PANCREAS. Eaton, S. Boyd; Ferrucci, Joseph T. Jr.; Benedict, Karl T. Jr. CRC Crit. Rev. Radiol. Sci.; 1: 165-206(May 1970).

Recent clinical and radiological contributions to diagnosis of pancreatic cancer, chronic pancreatitis, and pancreatic pseudocyst are reviewed. Clinical manifestations for these conditions are described; the advantages, drawbacks, and diagnostic interrelations of various radiological techniques are assessed for each. Tailored radiological approaches for the most common clinical patterns are developed. (auth)

48615 ISOTOPIC CISTERNOGRAPHY IN STURGE-WEBER SYNDROME. Chang, Jae C.; Jackson, George L.; Baltz, Richard (Harrisburg Hospital, Pa.). J. Nucl. Med.; 11: 551-3(Sep 1970).

The ^{131}I-labeled serum albumin administered by lumbar puncture for cisternography for the diagnosis of an incomplete form of Sturge-Weber syndrome (angiomatosis) and abnormal pattern of cerebrospinal fluid circulation in one patient is reported. The findings suggest that radioisotope cisternography is a useful adjunct in the diagnosis of atypical Sturge-Weber syndrome. (C.H.)

48616 INFLUENCE OF TREATMENT ON THE SURVIVAL OF PATIENTS WITH HEPATIC METASTASES DIAGNOSED BY LIVER SCANNING. Mansfield, Carl M.; Kramer, Simon; Southard, Martha E. (Thomas Jefferson University Hospital, Philadelphia). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 749-54 (Aug 1970).

The survival of 238 patients whose liver had been reported as positive for metastatic disease on the basis of radioisotope scans was reviewed. The study tends to confirm the impression that metastatic liver disease represents an unfavorable situation, and that the course of the disease cannot be appreciably altered by our present therapeutic modalities. These results, like those of most reported series, are based on a small number of cases. The patients had different modes of treatment for various malignancies. Although there were occasional good responses, the group as a whole did poorly. It is realized that therapy, in many patients, was not given specifically for hepatic metastases. Certain special procedures for the treatment of metastatic liver disease, such as hepatic artery infusion, irradiation or surgery, might have improved the survivals. It is worthy of note that the patients in the non-treated groups, in most instances, died slightly earlier than those in the treated group. This was especially true in the patients with lung cancer. In a larger series this tendency may become significant. (auth)

48617 IN VIVO DETECTION AND MEASUREMENT OF RADIATION IN THE HUMAN ORGANISM. de los Santos Salinas, Francisco (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 12: 573-91(Nov-Dec 1969). (In Spanish).

Methods for whole-body counting in man are described. Stressed are those based on sodium-iodide detectors. Also mentioned are tank procedures containing liquid scintillation material. Plastic scintillators, because of their high cost and low yield, are only briefly mentioned. Shielding requirements for whole-body counters are discussed. The possibility of measuring ^{32}P or ^{90}Sr through their bremsstrahlung is analyzed. (H.B.G.)

48618 ^{99m}Tc LABELING OF GELATIN FOR LIVER SCANNING. Roemer, J.; Dreyer, R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Isotopenpraxis; 6: 57-9(Feb 1970). (In German).

Gelatin is reported to be labeled with ^{99m}Tc. These labeled gelatin-particles are suited to liver scanning. Experiments show these particles to be stable. They can be produced easily. (auth)

48619 SHORT-COURSE RADIATION THERAPY IN CARCINOMA OF THE LUNG. Abramson, Norman; Cavanaugh, P. J. (Duke Univ., Durham, N. C.). Radiology; 96: 627-30(Sep 1970).

Two schedules of radiation therapy for carcinoma of the lung with regional metastases were compared in two groups of 42 patients each. One group received 6,000 R (tumor dose) in 30 fractions over six weeks, while another group received 2,000 R over five days, repeated after a three-week interval. A significant increase in one-year survival was noted in the second group. No increase in the amount of complications secondary to irradiation was noted. The short-course method is seen as a superior program for carcinoma of the lung with regional metastases. (auth)

48620 COMPUTER SIMULATION OF THE SCANNING PROCESS USING A SYSTEM RESPONSE TO LINE SOURCE DISTRIBUTION FUNCTION. Krackow, Kenneth A.; Gorten, Ralph J. (Veterans Administration Hospital, Durham, N. C. Duke Univ., Durham, N. C.). J. Nucl. Med.: 11: 523-6(Sep 1970).

A computer simulation of the scanning process was constructed to assist in the development and evaluation of computer techniques for radionuclide scan analysis. This simulation of radioisotope scans by computer is not without precedent; however, the use of simulation techniques to help develop and evaluate computer programs for scan analysis is a new and useful application of this idea. The model described is presented for the purpose of showing a simple technique which rapidly and inexpensively provides computer-compatible data analogous to real scan data collected for digital computer display and analysis. Simulation of the scanning process requires the derivation of a distribution function to express the collimator focusing characteristics for a given scanning system. The function described here represents a convenient method for modeling the response of a collimator to a sealed ^{203}Hg γ source. (auth)

48621 DIRECT COMPARISON OF A SMALL GAMMA CAMERA WITH A RECTILINEAR SCANNER FOR THYROID SCINTIGRAPHY. Harvey, R. F. (Middlesex Hospital Medical School, London). Clin. Radiol.; 21: 261-5(Jul 1970).

The efficiency of thyroid scanning with the gamma camera was compared with that of a rectilinear scanner. Satisfactory answers to the clinical problems were given in 85% of cases by the gamma camera, and in 95% of cases by the scanner. The techniques were equally efficient in the localization of functioning thyroid tissue, and in assessment of the iodine-trapping activity of nodules over 2 cm in diameter. (auth)

48622 RECTALLY ADMINISTERED RADIO-IODIDE IN THE DETECTION OF HEPATIC METASTASES. Gillespie, P. J.; Edelstyn, G. A.; Keyes, W. I. (Northern Ireland Radiotherapy Centre, Belfast). Clin. Radiol.; 21: 266-9(Jul 1970).

Several workers have reported a method of detecting hepatic metastases by examining the rise in count rate over the liver following the rectal administration of a small quantity of radioactive iodine. The results previously quoted have been surprisingly definitive with no overlap between patients with hepatic metastases and the control group. The authors have not been able to reproduce these results and have examined several other aspects of the iodine uptake pattern. No correlation could be established between these and the clinical status of the patient. (auth)

48623 RADIOLOGIC AND ISOTOPIC INVESTIGATION OF THE PANCREAS. Bouchier, I. A. D. (Royal Free Hospital, (London). Proc. Roy. Soc. Med.; 63: 434-6(May 1970).

Features suggestive of pancreatic pathology are described and relative effectiveness of various techniques used in diagnosing pancreatic disease are assessed. Emphasis is placed on pancreatitis and cancer. Techniques described are: the conventional barium meal, hypotonic duodenography, arteriography, percutaneous cholangiography, and isotopic scanning. The use of ^{75}Se-selenomethionine for scanning of the pancreas is discussed and it is emphasized that a liver scan should always be performed simultaneously. (H.L.W.)

48624 METHODS OF VISUALIZATION AND TREATMENT OF DIAGNOSTIC INFORMATION OBTAINED DURING RADIOISOTOPES SCANNING. Kolesnikova, N. V. Med. Radiol.; 15: No. 8, 3-8(Aug 1970). (In Russian).

Methods of visualization and treatment of diagnostic information from radioisotope scanning are surveyed. The foreign literature and a classification of the methods are given. (auth)

48625 ANGIOGRAPHY AND SCANNING IN LIVER DISEASE. Rossi, Plinio; Gould, Howard R. (St. Vincent's Hospital and Medical Center, New York). Radiology; 96: 553-62(Sep 1970).

Of 105 patients examined by liver scanning and celiac or hepatic angiography, a proved diagnosis was obtained in 77, with 26 cases of space-occupying masses, and 35 cases of cirrhosis. The two techniques appear to be complementary to each other, although angiography usually provides more information and may show more and smaller intrahepatic lesions. (auth)

48626 CHEMICAL FORM OF CYCLOTRON-PRODUCED ^{18}F USED IN BONE SCINTIGRAPHY. Chaudhri, M. Anwar; Gartside, J. M.; Ranicar, A. (Hammersmith Hospital, London). Brit. J. Radiol.; 43: 534-6(Aug 1970).

The uptake in bones and the clearance from blood of ^{18}F produced by the Medical Research Council Cyclotron at Hammersmith have been studied in rats and the results compared with those obtained by other workers for an aluminium-fluoro-complex and for unbound fluoride ions. The investigations indicate that the cyclotron-

produced ^{18}F is probably formed as a complex whose characteristics for bone scintigraphy are as good as of any other form of ^{18}F so far investigated. (auth) (UK)

48627 NUCLEAR PHYSICS IN MEDICINE. Brownell, Gordon L.; Shalek, Robert J. Phys. Today; 23: 32-6; 38(Aug 1970).

The production and uses of radioisotopes and the development of radioisotope cameras and scanners are reviewed. Also, the problems, radiation sources, and techniques for radiation therapy are discussed. (W.H.K.)

48628 DIAGNOSTIC VALUE OF RADIOISOTOPE SCANNING OF LUNGS. Stevenson, Carlos; Claure, Hugo; Abarzua, Bruny (Univ. Chile, Santiago de Chile). Rev. Med. Chile; 97: 701-7 (1969). (In Spanish).

Experience in 28 cases using ^{131}I-labeled macroaggregated human serum albumin is reported. Some aspects having to do with the correlation between scanning and x-ray findings are discussed. It is stated that lesions occupying less than 2 cm in diameter and/or located peripherally cannot be detected by the radioisotope method. In contrast with this limitation, lung scanning can adequately register the functional vascular component of hiliar or parenchymatous lesions, which is difficult to establish precisely through radiologic techniques. (auth)

48629 DIAGNOSTIC CRITERIA FOR 70 mm RADIOPHOTOFLUOROGRAPHY IN MASS SCREENING FOR HEART DISEASE. Pietilae, K.; Jaeaeskelaeinin, J.; Hakkila, J.; Siltanen, P. (Finnsih Heart Association, Helsinki). Ann. Clin. Res.; 2: 62-5 (1970).

Of 29,950 miniature x rays taken with an Odelca 70-mm U-camera, 408 suggested possible heart disease, and these were reexamined in this investigation. Of the 408 persons involved, 250 were healthy; thus the percentage of incorrectly-made positive interpretations was 61. The actual number of persons with heart disease was 158. The x rays of both those with heart disease and those considered healthy were interpreted with new criteria especially formulated for the Odelca 70-mm U-camera, because the x rays taken with this camera showed notable enlargement in the middle section. According to the new criteria the indications of heart disease for 105 of the 250 incorrectly-made positive interpretations were so slight that these persons would not have been asked to take part in the follow-up examination. This left the number of incorrect positive readings at 145, which was 35 percent of those attending the follow-up examinations. Among the 158 with heart disease, the changes in 12 were interpreted to be normal according to the new criteria; therefore, the percentage of incorrectly-made negative interpretations would have been 2.9 percent. (auth) (Finland)

48630 THE ^{131}I-ORTHO-IODOHIPPURATE PHOTOSCAN IN HUMAN RENAL ALLOGRAFTS. Dossetor, J. B.; Zweig, S. M.; Treves, S.; Ross, W. M. (Royal Victoria Hospital, Montreal). Can. Med. Ass. J.; 102: 1373-8(20 Jun 1970).

Nine examples, in seven patients, from a large cadaver renal allograft program, illustrate the value of radio-hippuran photoscans in differentiating causes of post-implant oliguria. Hippuran scans are shown to be more valuable than chlormerodrin scans when renal function is acutely depressed. Hippuran scans aided in the decision to remove kidneys in four cases of severe oliguria and to retain kidneys in two others. In two further examples, extravasation of urine was detected by scanning after radio-hippuran injection when other tests had failed to do so. The technique of radio-hippuran scanning has a place in the differentiation of acute and subacute renal dysfunction and has proved particularly valuable in the early oliguric complications of a cadaver renal transplant program. (auth) (Canada)

48631 USE OF RADIOACTIVE FIBRINOGEN FOR DETECTING REJECTION OF HUMAN RENAL TRANSPLANTS. Salamon, J. R. (London Hospital). Brit. Med. J.; 2: 517-21(30 May 1970).

Radioactive ^{125}I-labeled human fibrinogen was given to 11 recipients of cadaveric renal transplants and the radioactivity of the transplant was measured with a scintillation counter. In the six patients with no increase in radioactivity over the transplants there was no evidence of rejection. The five patients with an increased transplant radioactivity also had other evidence of rejection at that time. In one patient the test detected rejection in the absence of any other signs, and this result was afterwards confirmed by renal biopsy. The test in one patient was invalidated by hemorrhage occurring from the site of a renal biopsy. It is suggested that the technique may have particular value in recipients with delayed function of their transplants, but may also be useful in patients with functioning transplants in helping to confirm the diagnosis of rejection suspected on other grounds. (auth) (UK)

48632 PLACENTAL LOCALIZATION BY ISOTOPE SCANNING WITH ^{113m}In. RESULTS IN 200 PATIENTS. Wright, F. W. Brit. Med. J.; 2: 636-9(Jun 1970).

Placental scanning was carried out in 200 patients over a period of 22 months with ^{113m}In. It was found to be a reliable method of demonstrating the placenta, with a smaller radiation dosage than by x-ray methods. (auth) (UK)

48633 SYMPOSIUM ON NUCLEAR MEDICINE IN INTERNAL MEDICINE. 2. CLINICAL APPLICATION OF RADIOISOTOPES TO THYROID FUNCTION TEST. Kumahara, Yuichi (Osaka Univ.). Jap. J. Med.; 8: 204-7(Jul 1969).

Some of the recent progress in the use of radioisotopes in thyroid gland function tests is described. A new radioisotope $^{99m}TcO_4$ and scintillation camera were introduced to the study of thyroid function; a serial accumulation of $^{99m}TcO_4$ in the thyroid gland and the final patter can be observed on sequential scintiphotos. Thyroxine double-labeled with ^{131}I and ^{125}I is now used in metabolic studies; iodine compounds in urine and bile following intravenous administration of the double-labeled radiothyroxine can be identified by paper chromatographic and electrophoretic analysis. Radioimmunoassay has been used in the determination of plasma TSH concentration in various clinical states and proved to be sensitive enough to detect a concentration as low as 1.0 μu per ml. Various clinical tests using radioisotopes for establishing the diagnosis of goitrogenic hypothyroidism with iodine trapping defect in a 22-year-old male are also presented.

48634 RADIATION DOSE TO THE PATIENT IN CARDIAC RADIOLOGY. Ardran, G. M.; Hamill, J.; Emrys-Roberts, E.; Oliver, R. (Oxford Univ. United Oxford Hospitals). Brit. J. Radiol.; 43: 391-4(Jun 1970).

In 54 patients the exposure of the skin during fluoroscopy for cardiac catheterization was found to average 21 · 4 R. The corresponding total area exposure in R/cm^2 averaged 1560 R/cm^2. The average effective area of irradiation calculated from these readings was 117 cm^2. The results were compared with a recent study by Gough et al. (1968), and the implications of the area irradiated are discussed in relation to the bone marrow dose. (auth) (UK)

48635 APPLICATION OF CELLULOSE-NITRATE FILMS FOR ALPHA AUTORADIOGRAPHY OF BONE. Cole, A.; Simmons, D. J.; Cummins, H.; Congel, F. J.; Kastner, J. (Argonne National Lab., Ill.). Health Phys.; 19: 55-6(Jul 1970).

High resolution autoradiographs of bone containing ^{239}Pu were prepared by coating sections with their cellulose nitrate detector films that are selectively sensitive to alpha particles. The radiation damaged sites in the polymer were developed by etching with NaOH. The cellulose nitrate method provides an alternative to autoradiography with nuclear emulsions. It does not require darkroom facilities. The films are very stable and will not fog during long exposures at room temperature. (auth) (UK)

48636 X-RAY ABSORPTION MEASUREMENTS OF BONE MINERAL CONTENT. Spring, E.; Kairento, A.-L.; Verho, S. (Univ. Central Hospital, Helsinki). Soc. Sci. Fenn., Comment. Phys.-Math.; 36: No. 7, 95-102(1969).

An x-ray absorption method for determination of the content of minerals of bone was developed and studied. With four x-ray films, two taken of the patient and two of a phantom, along with filtration of the radiation and two different tube voltages, an accuracy of ±2% is obtainable in measurement of a particular point of the bone. The errors amount to ±6 – 9% in the measurement of large pieces of bone. (auth) (Finland)

48637 INVESTIGATION INTO THE CONTRIBUTION FROM SCATTERED RADIATION IN RADIOISOTOPE SCINTIGRAPHY. Scott, B. W. (Royal Prince Alfred Hospital, Camperdown, Australia). Australas. Bull. Med. Phys. Biophys.; No. 44, 11-16 (Jun 1970).

A comparison is made between the contributions of scattered photons to the counting rate at different energies (70, 140, and 391 keV), without reference to half-lives and other relevant properties of the nuclide used. Photons leaving the surface of the patient and entering a collimator are divided into three groups: primary photons from the target volume, having no energy loss from interaction, photons scattered by interactions with primary photons within the target volume, and photons scattered by photons entering from outside the target volume. The percentage compositions of counts in counting rates are obtained for various organs of different depths, volume and thickness. (auth) (Australia)

48638 RADIOISOTOPE DIAGNOSIS OF DISEASES OF THE GALLBLADDER. Slavnov, V. N. Med. Radiol.; 15: No. 4, 38-43(Apr 1970). (In Russian).

The technique of radioisotope investigation of the functional state of the gallbladder and study of anatomo-topographic peculiarities with the aid of radioiodine-bilignost and radioiodine-bilitrast are described. Investigations were carried out on a universal radiodiagnostic apparatus YPY-64, the radioisotope scanning on gamma-topograph ГТ-60. Under observation were two groups, namely: healthy persons (11) and patients (40) with different diseases of the gallbladder. On the basis of differences in the results obtained criteria were proposed for the assessment of the functional state of the gallbladder. (auth)

48639 RADIOISOTOPIC DETERMINATION OF CIRCULATION TIMES IN THE DIAGNOSIS OF LEFT-TO-RIGHT SHUNTS. Tarolo, G. L. (Univ., Milan); Binaghi, G.; Colombo, L. Radiol. Med.; 56: 1-22(Jan 1970). (In Italian).

An external isotope detection method with venous injection of ^{131}I-labeled albumin is proposed for the screening of cardiac left-to-right shunts. The method is based on the determination of the ratio between the mean general circulation time and the minimum heart-to-groin circulation time; these parameters can be measured by examination of the precordial and femoral external recordings. This test was performed in 11 subjects free of heart diseases, in 12 patients with heart diseases without shunts and in 3 patients with left-to-right shunts. It was found that the ratio between the above said circulation times in the whole of subjects without shunts had a mean value of 4.7 ± 0.7, whereas much higher values were obtained in the 3 patients with left-to-right shunts. The basic principles of the method and the possibility of its employment as a screening test are discussed. (auth)

48640 SCINTIGRAPHY AND ANGIOGRAPHY IN PRIMARY TUMOURS OF BONES AND JOINTS (CORRELATIONS, LIMITS, AND POSSIBILITIES). Kolar, J.; Bek, V.; Janec, J.; Schoolmeesters, J. E. (Charles Univ., Prague. State Univ., Nijmegen, Netherlands). Neoplasma; 17: 265-72(1970).

Based on 45 personal examinations with ^{85}Sr comparative evaluations of isotopic and angiographic investigations are given in primary bone and joint tumors of different origin. The best diagnostic results can be achieved by careful consideration of both these and other methods (routine radiograms, tomograms) and the clinical picture of the disease. Isotopic investigations offer quite non-specific informations from the diagnostic point of view, because they only illustrate the presence of a pathologic area of rebuilding of the bone tissue. Their main advantage is that silent secondary deposits can be detected in the skeleton very early. They give no reliable information about the extent of the tumorous invasion in the soft parts. Angiography offers on the contrary some valuable signs enabling a differentiation between malignant and benign conditions. It gives better information about the extent of the tumor in the soft tissues in the investigated site only. (auth)

Radiotherapy

Refer also to abstracts 48385, 48521, 48542, 48551, 48553–48555, 48557, 48559, 48565–48567, 48574, 48704, 48712–48714, 48717, 48719, 48722–48728, and 48733–48736.

48641 RADIOACTIVE ANTIBODY: A POSSIBLE ANTITUMOUR AGENT? Gaylarde, P. M. (Royal Free Hospital, London). Lancet; 1: 1119(23 May 1970).

It was suggested that if preparations of radioisotope-labeled antitumor sera with sufficient activity could be produced, they could be used in the same manner as iodine isotopes are used for the treatment of thyroid metastases. Another application would be in the diagnostic location of metastases. (UK)

48642 EFFECTS OF HIGH-ENERGY PROTONS ON HEALTHY ORGANS AND MALIGNANT TUMOURS, INCLUDING A STUDY OF RADIATION PROTECTION BY LOCAL HYPOXIA. Stenson, Stig (Uppsala Univ.). Acta Univ. Upsal., Abstr. Uppsala Diss. Med.; No. 73, 1-21(1969).

Effects of high energy protons and 220 kV roentgen rays on healthy organs and malignant tumors were investigated. The possibility of protecting the intestinal mucous membrane from radiation damage by means of the oxygen factor was explored; and an attempt was made to bridge the gap between experimental work with proton beams and the clinical use of the beams in radiotherapy. Grossly and histologically, high-energy protons and roentgen rays have been found to induce the same type of changes in rabbit skin, in the rectum of the rat, and in the rabbit V 2 carcinoma. As to relative biological efficiency, the ratio between roentgen and proton doses, creating equivalent weight changes and mortality at abdominal irradiation of rats, was found to be 0.77 ± 0.18. The ratio between roentgen and proton doses which induced histologically the same damage in the rat rectum was in the range 0.6–0.7. In man, proton radiation induced the same type of changes in skin and genital carcinomas as roentgen and radium treatment. In proton treatment of genital carcinoma, the critical organ is the rectum. Infusion of vaso-constricting and oxygen-reducing substances into the rat rectum created local hypoxia in the rectal wall and protected the mucous membrane from radiation damage. The study showed that when high-energy protons are being concerned for radiotherapy the biological part of the treatment planning may to a considerable extent be based on general radiological experience. It is difficult to come to any conclusion concerning the therapeutical value of the treatment. It can be concluded, however, that beams of high-energy protons may be used clinically for treatment of malignant tumors. The planning of radiotherapy with high-energy protons should be based to a considerable extent on general radiological experience. (auth) (SW)

48643 HYPERBARIC OXYGEN IN RADIOTHERAPY OF HEAD AND NECK CARCINOMA: INTERIM REPORT OF A CONTROLLED CLINICAL TRIAL. Henk, J. M.; Kunkler, P. B.; Shah, N. K.; Smith, C. W.; Sutherland, W. H.; Wassif, S. B. (Velindre Hospital, Cardiff, Wales). Clin. Radiol.; 21: 223-31(Jul 1970).

A prospective controlled trial of hyperbaric oxygen in the radiotherapy of head and neck tumors is described, using a regime of 10 fractions in 3 weeks. Each patient is allocated at random to treatment in either air or oxygen after prescription of the tumor dose. Identical beam direction techniques are used in air and oxygen treatments. Higher survival rates, and significantly higher local tumor control rates have so far been observed in the oxygen compared with the air series, with no difference in complications. It is concluded that under the conditions of this trial, high-pressure oxygen is an effective adjuvant to radiotherapy. (auth)

48644 CARCINOMA OF THE PENIS RADIOTHERAPEUTIC APPROACH FOR THE PRIMARY LESION. Green, J. P.; Lowy, R. O.; Vaeth, J. M. (Claire Zellerbach Saroni Tumor Inst., San Francisco. Mount Zion Hospital and Medical Center, San Francisco). Radiol. Clin. Biol.; 39: No. 1, 1-8(1970).

Radiation therapy can sterilize at least 50% of the early cancers of the glans, penis, or prepuce, and should be offered as the primary mode of treatment in order to spare the mutilation of penectomy. Sound radiation therapy compromises neither surgery nor the chance for cure if tumor persists or recurs. A satisfactory technique utilizing ^{137}Cs teletherapy is applied in three cases and is reported. (auth)

48645 FACTORS INFLUENCING CURE IN THE RADIOTHERAPY OF POST CRICOID CARCINOMA. Kalavathi, N. (Western Pennsylvania Hospital, Pittsburgh). Clin. Radiol.; 21: 248-52(Jul 1970).

One hundred and three cases of post-cricoid carcinoma were treated at Sheffield, England between 1950 and 1961. Eight patients survived over 5 years. The prognosis was better after radical treatment for lesions under 5 cm long. Most survivors received a tumor dose between 5000 and 5500 R in five weeks. Two patients developed a complicating radiation myelitis. (auth)

48646 EXPERIMENTAL STUDY OF THE EFFECT OF NONUNIFORM IRRADIATION. Aliev, B. M.; Yushkov, S. F. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol.; 15: No. 8, 60-4(Aug 1970). (In Russian).

In three series of experiments on $C_{57}BL \times CBA$ mice hybrids of the first generation, the effect of nonuniform x irradiation of 298-sarcoma through a Bucky diaphragm 1 mm thick with a diameter of 1 mm and the ratio between closed and open areas (3/0) of 1:1, 2:1, and 4:1 was studied. One of the decisive factors in obtaining a therapeutic effect in nonuniform irradiation is the value of the absorbed dose in open and screened areas of the tumor, as well as the ratio of dose values between them. A significant inhibition of growth of 298-sarcoma was obtained in the absorbed dose in screened areas of 1400 to 2000 rad; in open-4500 to 5500 rad. A grid with a ratio of 3/0 = 1 is the optimal diaphragm for ensuring a rational dose distribution at the level of the center of the tumor in single irradiation. (auth)

48647 WHY HAS RADIOTHERAPY IN ADVANCED STAGES OF CANCER BECOME LESS RISKY? Ringleb, D.; Barth, G. (Univ., Giessen, Ger.). Med. Klin. (Munich); 64: 2357-62(19 Dec 1969). (In German).

At precent, radiotherapy is applicable in patients with advanced cancer because of reduction in both early and late reaction to radiation. Reasons for the improvement reside in technical developments. Discussed are photon beams, particle radiation, especiall cyclotron-produced electron beams up to 45 MeV. Also discussed are depth distribution of the various beams with respect to dependency on energy. (H.B.G.)

48648 TIME-DOSE RELATIONS IN RADIOTHERAPY. Fowler, J. F.; Thomlinson, R. H.; Howes, A. E. (Hammersmith Hospital, London). Eur. J. Cancer; 6: 207-21(Jun 1970).

At present the doses prescribed by radiotherapists are determined by the maximum tolerable reactions of normal tissue rather than by the response of the tumor. Combinations of total dose (in several fractions) and overall times required for normal tissue tolerance in various fractionation schedules can now be predicted with fair reliability. The radiobiological basis of such relationships are reviewed. The magnitudes of cellular repopulation and of prompt repair from intracellular radiation injury are compared. It is shown that the latter effect is the greater for conventional fractionation regimes, and also for regimes with smaller numbers of larger dose fractions. The response of a tumor will vary with the size of the dose and the length of the interval between doses according to the dynamics of the cell population and changes in its oxygenation. In order to achieve better therapeutic ratios radiotherapists will need to take into account these properties of tumors together with the somewhat better established time-dose relationships for normal tissues. Some improvement in oxygenation of tumors is demonstrated after irradiation. The possible effects of this re-oxygenation upon optimum fractionation are discussed, with special reference to recent experimental results from transplanted mammary tumors in C_3H mice. (auth) (UK)

48649 STUDY OF TISSUES AFTER RADIOTHERAPY WITH A VIEW TO RECONSTRUCTIVE SURGERY AFTER CANCER. Calvet, J.; Marques, P.; Planel, H.; Coll, J. Rev. Laryngol., Otol., Rhinol.; 91 Suppl., 3-4(1970). (In French).

The examination of tissues during or after cobaltherapy, especially of the tissues situated in the field of irradiation, but away from the tumor is reported. 40 samples taken from the buccal mucous and also from skin, muscle, and bone were analyzed. The reaction of the mucous under the effect of cobalt is very precocious in half the cases as early as 600 rads. The regeneration of the mucous after radioepithelitis is always complete after one and a half years. The vascular and cutaneous derm attacks are the most important at a distance from the irradiation. On the other hand, the muscles appear little changed. (auth) (France)

48650 TREATMENT OF TOXIC NODULAR AND DIFFUSE GOITRE WITH RADIOACTIVE IODINE. LATE RESULTS AND USE OF CARBIMAZOLE. Viherkoski, M.; Lamberg, B.-A.; Hernberg, C. A.; Niemi, E. (Maria Hospital, Helsinki). Acta Endocrinol.; 64: 159-70(1970).

The results of treatment of hyperthyroidism with radioiodine were evaluated in a series of 387 patients treated between 1959 and 1963. The observation time was 8 years. The first year incidence of hypothyroidism was 14.5%. There was a distinct difference between patients with toxic nodular and toxic diffuse goitre: 11.8% in the former and 25.6% in the later. Among all patients 77% had nodular goitre. After the first year, the yearly increment of hypothyroidism was 1-2%. 14% of the patients were pretreated with antithyroid agents. In those not treated, severe post-treatment reactions occurred in 4% of the cases. A few patients developed an impending crisis and one patient succumbed in a thyroid crisis. The importance of this type of pre-treatment in severely ill patients or in patients with complicating conditions is stressed. In the pretreated group of patients, the incidence of hypothyroidism was smaller than in patients not treated in this way and the patients more commonly required more than one treatment dose. The percentage of severe reactions was much smaller in the 1959-1963 series of patients than in our first series, probably because of this pre-treatment. The administration of antithyroid drugs for only a few weeks after the radioiodine dose did not influence the results. (auth)

48651 CHRONOLOGICAL CHANGE OF RADIOTHERAPY FOR CHILDREN. PART 1. FOR BENIGN TUMORS. Watanabe, Tetsutoshi (Tokyo Univ.). Jap. J. Clin. Radiol.; 14: 669-72 (Aug 1969). (In Japanese).

On child patients treated at Radiological Department of Tokyo University Hospital for 13 years from 1955 to 1967, the chronological change of their benign diseases was studied. The results obtained were as follows; the total number of child patients was 1,113 in this period. Of these, 621 cases (56.5%) were benign diseases and 492 cases (43.5%) were malignant tumors. The percentage of benign diseases was 75% in 1955 and 1956, but it decreased from year to year, and fell to 25% in 1966 and 1967. This tendency was observed commonly in female as well as in male. Hemangioma accounted for 51.5% of all benign diseases, and it was found more in female than in male. Tonsillar hypertrophy and allergic coryza accounted for 19% of all benign diseases, but they rapidly decreased after 1957, and there were only five cases in five years from 1963 to 1967. Tuberculous cervical lymphadenitis was 15.2%, but only four cases were found for seven years from 1961 to 1967. Preventive irradiation of keloid accounted for 14.5%, and it tended to increase in recent years. From the above results, it was concluded that child patients with benign diseases subjected to radiotherapy tend to decrease in recent years, and most of those treated by radiotherapy at present are hemangioma and prevention of keloid after plastic surgery. This tendency is desirable because radiotherapy should be applied meticulously to benign diseases in childhood. (NSA of Japan)

48652 USE OF BETA RAYS IN THE TREATMENT OF CHRONIC ECZEMA AND PSORIASIS. A PRELIMINARY REPORT. MacDonald, R. H.; Bratherton, D. G. (Addenbrook's Hospital, Cambridge, Eng.). Brit. J. Dermatol.; 82: 283-6(Mar 1970).

Twenty-four patients with resistant patches of eczema and six patients with resistant patches of psoriasis were treated with beta rays using a strontium-90 source. The results are discussed and compared with those obtained with other similar methods of treatment. It was concluded that in carefully selected patients with benign dermatoses beta ray therapy from a ^{90}Sr source is safe and effective. (auth)

48653 TELECOBALT THERAPY OF ESOPHAGEAL CANCER. Matsuura, Yasuhiko (National Hospital of Iwakuni, Yamaguchi, Japan). Jap. J. Clin. Radiol.; 14: 452-9(Jun 1969). (In Japanese).

Thirty-seven cases of esophageal cancer, treated by telecobalt irradiation from April 1958 to December 1964, were studied, and the following results were obtained. The clinical stage of all cases studied were T_3, in which the filling defect was more than 6 cm in length, but the infiltration to adjacent organs was mild. The patient's complaints, chiefly related to stenotic symptoms, were removed by the radiotherapy in 98% of the cases, and on x-ray picture after the radiotherapy, reduction or disappearance of the filling defect was found in 76%. One year survival percentage of these cases was 33%, and 2 patients survived more than 5 years. The mean survival time was 13 months. When the filling defects were classified into 3 types, serrated, spiral, and infundibular types based on their shape, it was presumed from the improvement of x-ray findings and the prolongation of mean survival time that the radiosensitivity of the serrated type was higher than those of the other two. From the data upon these cases, the optimum dose seemed to be 5000 ~ 7000R/5 ~ 6W. As the side effects of radiotherapy, one case of radiation pneumonitis and two cases of rupture of aorta with fatal outcome were observed. (NSA of Japan)

48654 OUR EXPERIENCES WITH THE TREATMENT OF MALIGNANT TUMOURS OF THE TONGUE IN THE YEARS 1950-1963. Lintner, L. (Charles Univ., Prague). Neoplasma; 17: 293-8(1970).

The clinical picture, the method of treatment, the 5-year and 10-year results of treatment are given for 52 patients suffering from malignant tumor of the tongue, treated at the Oncological Department of the Radiologic Clinic of the Medical Faculty Hospital in Prague in the years 1950 to 1963. Of 52 patients, 16 have survived for 5 years, eight of them for already 10 years and more. (auth)

48655 PLAN FOR A CONVERSATIONAL SYSTEM WITH A COMPUTER FOR THE AUTOMATION OF EXTERNAL IRRADIATION AND THE OPTIMIZATION OF TREATMENT PLANES. Massenti, S. (Univ., Pisa, Italy); Mancini, P. Radiol. Med.; 56: 61-72(Jan 1970). (In Italian).

Optimal requirements are suggested for a system of data processing for use in clinical radiotherapy. These include the adoption of processes for the optimization of treatment planes by means of conversational methods, organization of input and output systems to insure operational rapidity and flexibility and hence facile clinical employment, overall automation of the irradiation procedure, and storage of data. These premises were used in the planning of a system for the handling of information and for the automation of irradiation, whose special features depend on its being linked to an electronic computer center. The organization, operational modalities and equipment of this system are described. (auth)

48656 RADIATION TREATMENT RESULTS IN BRAIN TUMOURS. Jedlicka, P.; Chodounsky, Z.; Topol, O. (Charles Univ., Prague). Neoplasma; 17: 283-91(1970).

For the course of a brain tumor chiefly its biological nature as revealed by its histological structure is decisive. Among the astrocytic tumors there can be demonstrated about four types of the course of the disease with four corresponding types of anaplasia. A similar relationship can be observed also in other types of tumors. Medulloblastoma appears to be a relatively more benign tumor than glioblastoma, this being due to its radiosensitivity. Patients treated with a dose over 3000 R have survived on the av-

erage longer, as much as twice as long, than patients treated with lower doses. Brain tumors are radiosensitive and treatment failures should be attributed to a lack of knowledge of the actual tumor area affected by the radiation. (auth)

48657 GENERAL PRINCIPLES OF RADIATION TREATMENT OF TUMOUR OF THE CENTRAL NERVOUS SYSTEM. Topol, O. (Charles Univ., Prague). Neoplasma; 17: 273-81(1970).

The majority of malignant tumors are radiosensitive. The degree of radiosensitivity depends most probably on the histological degree of malignancy. On the basis of Strandquist's curve for skin necrosis following radiation there was determined the tolerance dose of the CNS for radiation. The applied dose is curative when the amount of ionizing energy absorbed in the tumor and the amount of energy absorbed in the adjacent healthy tissue are in an optimal relationship. Only then the biological situation in the tissue is normalized, and cure ensues. Cerebral edema often prevents the application of the optimal dose. In radiation treatment errors are very often made in the estimation of the localization and size of the tumor. If the tumor is operable, in the first place the operation should be performed and then actionotherapy applied. In inoperable tumors only irradiation is carried out. It is recommended to operate more frequently than hitherto after irradiation, when it is found that the inoperable tumor has become operable as a result of the irradiation. This procedure has met with success in tumors of other organs and it should, therefore, prove to be effective also in brain tumors. In medulloblastoma irradiation is regional, in all the other tumors of the CNS it is centered. (auth)

48658 HIGH ENERGY ELECTRON BEAM TREATMENT PLANNING FOR BETATRON 10 TO 24 MeV. Nelson, Richard F. (City of Hope National Medical Center, Duarte, Calif.). Acta Radiol., Ther., Phys., Biol.; 9: No. 1, 73-80(Feb 1970).

A brief review of the historical development of the use of high energy electrons for therapy is presented. Various examples of treatment plans showing the versatility of this modality are given. A table showing the comparative advantages and disadvantages of this method of treatment versus cobalt-60 γ and 250 kV x radiation is also presented. (auth) (Sweden)

48659 USE OF ^{99m}Tc-SULPHUR COLLOID SCAN PRIOR TO INTRAPERITONEAL INSTILLATION OF RADIOISOTOPES FOR THERAPY PURPOSES. Vigario, G. D.; Wetzel, R. A.; Constable, W. C. (Univ. of Virginia, Charlottesville). Brit. J. Radiol.; 43: 582-3(Aug 1970).

A scan is recommended prior to the installation of a therapeutic dose of radioisotope in the peritoneal or pleural to exclude a non-uniform distribution. Colloidal chromic phosphate (^{32}P) is preferred for therapy and ^{99m}Tc-sulphur colloid is preferred as a scanning compound. A scan or gamma camera image is obtained during distribution. (UK)

48660 TELEGAMMA THERAPY IN CARCINOMA OF THE HYPOPHARYNX WITH SPECIAL REFERENCE TO CYTOLOGICALLY VERIFIED METASTATES IN THE NECK. Werner, Goeran; Baaryd, Ingvar (Radiumhemmet, Stockholm. Statens Stralskyddsinstitut, Stockholm). Acta Radiol., Ther., Phys., Biol.; 9: No.2, 129-43(Apr 1970).

An analysis of a total of 83 patients with hypopharyngeal carcinoma treated with ^{60}Co γ teletherapy during the period 1955 to 1965 is presented. The treatment methods are discussed. The total 5-year survival rate was approximately 17%, and in patients with upper hypopharyngeal carcinoma it was about 18%. The survival rate was 15% for 52 patients with cytologically verified metastases in the neck. The series was prognostically unfavorable, with 64 men and 19 women, and an average age of about 60 years. (auth) (Sweden)

Blast and Thermal Effects

Refer also to abstract 48485.

48661 (ABCC-TR-6-68) BIBLIOGRAPHY OF PUBLISHED PAPERS OF THE ATOMIC BOMB CASUALTY COMMISSION. (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). 1968. 7p. Dep. CFSTI.

A list is presented of 45 papers published during 1968 that report the findings of follow-up studies on residents of Hiroshima and Nagasaki exposed to atomic bombing or the results of epidemiological studies on the general population of these two cities. (C.H.)

Radiation Effects on Animals

Refer also to abstracts 48390, 48391, 48442, 48484, 48503, 48586, 48587, 48589, 48590, and 48753.

48662 (UCSF-10-P-2-114) SIMILARITIES AND DIFFERENCES BETWEEN UV AND IONIZING RADIATION DEATH. Painter, Robert B. (California Univ., San Francisco. Lab. of Radiobiology). [1970]. 10p. (CONF-700610-6). Dep. CFSTI.

From 4th International Congress of Radiation Research, Evian, France.

Comparisons of the effects of ultraviolet and x radiation on mammalian cells are made using data from recent literature. Studies on survival levels and radioinduced damage to DNA of Chinese hamster cells indicated that ultraviolet radiation caused 1,000 times as much damage as x rays. Studies on HeLa cells showed that although x radiation caused mitotic delay, nearly every cell arrived at and completed the first mitosis; however, with uv, cell death often occurred during the first S phase after irradiation and many cells never arrived at mitosis. Mechanisms of repair of sublethal damage by mammalian cells are compared for uv and x radiation. Repair of x-ray damage begins immediately, requires 1½ to 2 hrs for maximum expression, and is relatively independent of cell cycle position. The action of uv, however, suggests that the main problem encountered by the cell is successful completion of DNA replication. (H.L.W.)

48663 RECOVERY OF G_2 CELLS IN PEA ROOT MERISTEMS: SURVIVAL AND MITOTIC DELAY FOLLOWING IRRADIATION. Webster, P. L.; Van't Hof, J. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot.; 10: 145-54(Apr 1970).

The effects of γ irradiation on the capacity of G_2 cells to complete one post-irradiation mitosis and mitotic delay of these G_2 cells were investigated. Recovery with respect to both of these parameters of damage can occur in the absence of any progression through the cell cycle; however, the kinetics of recovery suggest that the two parameters, i.e., failure to divide and delay in division, reflect damage to different systems in the cells. Conditions of extreme hypoxia prevent recovery from damage leading to failure to divide, while recovery with respect to mitotic delay is much less sensitive to such conditions. An inhibitor of DNA synthesis, 5-fluorodeoxyuridine, while preventing passage of cells through S, had no effect on either recovery system. A comparison of the radiosensitivity of the whole meristem in terms of its subsequent growth with that of a population of its component cells demonstrated that the former may be quite independent of the latter. (auth) (UK)

48664 PHASE PROGRESSION IN TWO DOSE RESPONSE OF EHRLICH ASCITES TUMOR CELLS. Dittrich, W.; Goehde, W. (Westfaelische Wilhelms Univ., Muenster, Ger.). Atomkernenergie; 15: 174-6(1970).

In two genetically related clones of Ehrlich ascites tumors of different radiosensitivity the fractions of cells in the phases of the generation cycle in vivo were determined from DNA-histograms at different time intervals after x-irradiation. All DNA-histograms were delivered from a high speed "impulsecytophotometer" (ICP) described in detail. Both clones show different phase shifts that indicate a relatively higher resistance of the radioresistant mutant clone not only with respect to lethal damage but also to the radioinduced inhibition of mitosis and DNA-synthesis. The differences in phase shifts were explained by observed differences in pattern of recovery from sublethal damage. (auth)

48665 CHANGES IN INTERNEURONIC CORRELATIONS OF THE SYMPATHETIC GANGLION IMMEDIATELY AFTER EXPOSURE TO IRRADIATION. Mtskhvetadze, A. V. Soobshch. Akad. Nauk Gruz. SSR; 57: 193-6(Jan 1970). (In Russian).

New findings on changes of the membranous potential, excitatory postsynaptic potential and the peak of individual cells of the sympathetic ganglion following irradiation are reported. The study was carried out using intracellular abduction of the potentials. (auth)

48666 GRAFT VERSUS HOST REACTIVITY OF EMBRYONIC LYMPHOID CELLS, ACTIVATED BY IRRADIATED THYMUS AND/OR BURSA CELLS. Sharon, R. (Tel Aviv Univ., Israel). Experientia; 26: 909-10(15 Aug 1970).

Cells from chicken thymus and the bursa of Fabricius were exposed to 2000 R γ radiation prior to contact with lymphoid cells from chick embryos. Chick embryos were inoculated with lymphoid cells, irradiated bursa cells, irradiated thymus cells, a combination of embryonic cells and irradiated thymus cells, and a combination of embryonic cells and irradiated bursa cells. The results indicated that the lesions were the product of the embryonic lymphoid cells which must have been transformed into competent cells by means of a factor released from the thymus or the bursa. (H.L.W.)

48667 RADIOSENSITIVITY OF RAT BONE-MARROW CELLS. Comas, F. V. (Oak Ridge Associated Universities, Tenn.). Int. J. Radiat. Biol.; 17: 549-57(1970).

The radiosensitivity of rat bone-marrow cells was determined by the spleen-colony technique. When the marrow cells were irradiated in vivo, the D_0 was 97 rads, and the extrapolation number was 52. Similar results were obtained after in vitro irradiation: D_0 = 94 rads, and extrapolation number = 41. Some observations are also reported on the proliferative capability of irradiated bone-marrow and spleen-colony cells injected into heavily irradiated recipient rats. (auth) (UK)

48668 DESTRUCTION OF LYMPHOID CELLS BY ACTIVATED HUMAN LYMPHOCYTES. Hardy, D. A. (Univ. of Birmingham, Eng.); Ling, N. R.; Wallin, J.; Aviet, T. Nature (London); 227: 723-5(15 Aug 1970).

It is stated that the mitotic activation of lymphocytes in vitro by histocompatibility antigens presents some surprising features; for example, human lymphocytes are activated by isoantigens on fresh or x-irradiated lymphocytes of another donor (the mixed lymphocyte reaction) but not by isoantigens on human fibroblasts and HeLa cells or on leucocytes killed in various ways, or on leucocyte fragments. Human lymphocytes are activated by x-irradiated cells from various human lymphoid cell lines in a reaction closely similar to a unidirectional mixed lymphocyte reaction, but of considerably greater intensity. Experimental work demonstrates an inbuilt reactivity of lymphocytes to certain antigens and the importance of "presenting" the antigens in the right way to the lymphocytes. In the study described it was demonstrated, using a chromium release technique (J. Exp. Med. 125: 721(1967)) that human lymphocytes incubated for several days with irradiated lymphoid cell lines (LCL) showed a markedly enhanced capacity for destruction of these cells. The cytotoxic effect seemed to require direct cell to cell contact; it was not shown with supernatants of mixed cultures of irradiated LCL cells and blood lymphocytes. Enhanced cytotoxic activity of blood lymphocytes of an adult was first apparent one day after incubation with x-irradiated LCL cells and was maximal at about six days. Source lymphoma cells were lysed as effectively as EB cells by lymphocytes pre-stimulated with x-irradiated EB cells, although x-irradiated mouse lymphoma cells did not induce significant mitotic activation of human lymphocytes in culture. Lymphocytes from human thymus were activated in terms of DNA synthesis by incubation with x-irradiated EB cells. (UK)

48669 AN INVESTIGATION OF FACTORS INFLUENCING MITOTIC G_2 DELAY IN SYNCHRONOUS CULTURES OF HUMAN KIDNEY CELLS AFTER X-IRRADIATION. Scaife, J. F.; Brobee, H. (Euratom Joint Research Center, Ispra, Italy). Can. J. Biochem.; 47: 237-49(Mar 1969).

Factors affecting mitosis were studied in human kidney T-cells synchronized by two exposures to 7.5 mM thymidine. Biochemical measurements were correlated with the position of the cells in the cell cycle from S to mitosis. Anaerobic conditions during S, although not inhibition of respiration, prevented cells from progressing to mitosis. ATP production is largely anaerobic and glycolytic metabolism is sufficient for a cell to complete mitosis once it has entered G_1 or prophase. Both RNA and protein synthesis are required in G_2 for the initiation of cell division, while treatment with carbon monoxide or thiol blocking agents also prevents mitosis. Postirradiation mitotic delay was greater for cells irradiated in G_2 than for cells irradiated in S. This G_2 delay was reversible if the cells were blocked in S by addition of excess thymidine. Pretreatment with 5 to 15 mM cysteamine largely protected irradiated cells from mitotic delay. Cysteine at a concentration of 20 mM and AET at 10 mM were only weakly protective, while 20 mM mercaptoethanol was ineffective. All these compounds added after irradiation were ineffective. Anoxia during irradiation had a slight protective effect. Mitotic delay was enhanced by lowered concentrations but not reduced by elevated concentrations of calcium, while agmatine before or after irradiation was without protective effect. The protein thiol content of cells increased from S to maximum at metaphase, while the nonprotein thiol content was unchanged. X irradiation of up to 500 R had no effect on the protein or nonprotein thiol content of the cell up to mitosis. The intracellular ATP content was maximal for cells in G_2, then falls subsequently to mitosis. Irradiation slows this premitotic accumulation of ATP. The respiration rate per cell is constant up to mitosis then drops sharply following division. Irradiation has no effect on respiration. Decreased specific activities of DNA from cells irradiated in S and incorporating ^{3}H-TdR postirradiation over a 2-hr period suggest a pool effect as the mechanism of reduced thymidine incorporation. No evidence could be obtained for any significant breakdown of DNA following irradiation. Prolonged DNA synthesis following irradiation is not considered to be the primary reason for mitotic delay. The radiation block is located less than 30 min before the onset of prophase and is possibly correlated with a condensation mechanism of the chromatin strands. (auth) (Canada)

Invertebrates

Refer also to abstracts 48478, 48482, 48523, and 48524.

48670 EFFECTS OF X IRRADIATION ON EMBRYOGENESIS, INFECTIVITY, AND MIGRATORY BEHAVIOR OF THE LARVAE OF TOXOCARA CANIS (WERNER, 1782) IN WHITE MICE. Lyles, Demetrice Irving. Columbus, Ohio; Ohio State Univ. (1969). 162p.

Thesis.

Naturally ovulated eggs for embryogenesis studies were harvested at 2-hr intervals from adult female Toxocara canis and kept at a temperature of 8°C to prevent development prior to irradiation. Egg samples were incubated at room temperature (29 to 30°C) after irradiating with a constant potential x-ray machine operating at 250 kV and 10 mA. The emitted radiation had a half value layer of 0.5 mm of Cu at a vertical distance of two inches. No external filter was used. The delivery rate was 775 R/minute. Development of the eggs was observed for 10 consecutive days and on the 15th day. Ninety-two percent larval development occurred in the nonirradiated control eggs. In the eggs irradiated at 5, 10, 20, 40, and 80 kR larval development was 88, 79, 36, and 0%, respectively. Retardation in cleavage rate increased with the increase in x-ray dose. In eggs irradiated at 80 kR, over 70% of the eggs died in the six- to ten-cell stage with only 20% development to the mulberry stage. There was no further development. In the eggs irradiated at 40 kR, over 70% of the eggs died in the mulberry stage. Only 3% of the eggs developed to the larval stage. Morphological changes of abnormal cleavage, vacuolation, and granulation increased with the increase in x-ray dose. Naturally ovulated eggs used for study of the migratory behavior of Toxocara canis larvae in mice were collected daily from adult female worms and incubated at room temperature (29 to 30°C) for 30 days. The eggs were kept at 8°C until used. Sixteen mice were used for each of six experiments and each given 2000 infective eggs of Toxocara canis by intubation. Two mice were euthanized daily for seven consecutive days and again on postinfection day 14. The various organs were digested by the use of a 1% trypsin solution after finely chopping with a Waring blender. However, the carcass, intestine, and genitalia were digested with the use of a ½% acid pepsin solution. The intubation temperature was 37°C. The intestinal wall and genitalia were incubated for 2 hr. All other tissues were incubated for 4 hr. In the control mice given nonirradiated eggs of Toxocara canis, the average number of larvae recovered from each mouse was 453 with an infectivity of 22.65%. At x-ray dose levels of 5, 10, 20, 40, and 80 kR the average number of larvae recovered from each mouse was 412, 291, 241, 273, and 120 respectively with infectivities of 20.60, 14.55, 12.05, 13.65, and 6% respectively. A delayed larval migration from the liver increased with the increase of x-ray dose. This was evident by the increased percentage number of larvae recovered from this organ. There was also delayed larval migration to the carcass and brain. The delayed larval migration of Toxocara canis is believed to be due to decreased vitality and motility of the larvae resulting from radiation injury. The decreased vitality of the larvae resulted in a decrease in larval invasive ability. (Diss. Abstr. Int., B)

48671 STUDY OF RADIORESISTANCE IN VARIOUS ANIMALS. PERSPECTIVES THUS OPENED IN RADIOPROTECTION. Niaussat, P. Rev. Corps Sante Armees; 9: 243-66(Apr 1968). (In French).

The effects of ionizing radiations on living cells are briefly summarized. The present knowledge available on the natural radioresistance in different species is then reviewed. Observations made on the radioresistance of arthropods of arid zones are then reported. These include Limulus polyphemus L.; five species of scorpions, and five species of insects. The various hypotheses made to analyze the causes of high radioresistance in these arthropods are discussed in detail. The logical consequences that these data may indicate on the mechanisms of radioprotection and thus of eventual medico-military applications are discussed. (tr-auth)

48672 RETICULOENDOTHELIAL SYSTEM OF TUNICATES. Freeman, G. (Univ. of California, San Diego, La Jolla). RES, J. Reticuloendothel. Soc.; 7: 183-94(Feb 1970).

A speculative attempt to identify the probable structural bases in tunicates for the evolution of the reticulo-endothelial system of vertebrates is presented. Three aspects of the biology of these animals are selectively reviewed: the kinds of tissue differentiations that the blood cells of tunicates are capable of manifesting; the different functional roles of phagocytes in tunicates; and colony specificity in tunicates. Perophora bermudensis and Ecteinascidia tortugenesis colonies increase in size and reproduce asexually in the same way that P. viridis does. If these species are irradiated with 5000 R of x radiation budding will not take place. However,

if an irradiated preparation is injected with blood from an unirradiated individual it will bud. It has been established that the lymphocyte cell class is necessary if budding is to take place for each species. A series of experiments were done in which preparations of one species were irradiated so that they would not bud and blood cells from another species were injected into the irradiated species. The irradiated preparations were then observed in order to establish what type of buds would form. A detailed cytological examination was done for some of the buds which formed in the interspecific combinations. All of the cell types which made up the organs of the zooid appeared to be of donor type for those organs in which species specific identifications of cell types could be attempted. Host cells could only be identified in the vascular system of the zooid. (C.H.)

48673 GROWTH STIMULATING AND INHIBITORY ACTIONS OF X-RAYS ON HYDRA. Mitra, Jaganmay (Presidency Coll., Calcutta). Sci. Cult. (Calcutta); 35: 514-19(Sep 1969).

Cultures of Hydra vulgaris were exposed to 50 to 50,000 rad x radiation following 24 hrs of starvation and immediately afterwards they were transferred to petri dishes containing culture medium. It was found that a dose of 50 to 1,000 rad produced a temporary acceleration of population growth that persisted to the 20th day after irradiation. A dose of 5,000 to 15,000 rad produced an inhibition of growth up to the 32nd day after irradiation and a lethal effect was produced by 20,000 to 50,000 rad. (H.L.W.)

Vertebrates

Refer also to abstracts 48392, 48394, 48395, 48408, 48410, 48415, 48423–48425, 48427, 48428, 48430–48432, 48434, 48439–48441, 48443–48449, 48451, 48452, 48490, 48492, 48507, 48513, 48584, 48585, 48594, and 48642.

48674 (AD-698480) PERFORMANCE OF SEQUENTIAL TASKS BY UNRESTRAINED MONKEYS FOLLOWING A 4200-RAD PULSE OF MIXED GAMMA-NEUTRON RADIATION. Young, R. W.; Kessler, D. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Sep 1969. 25p. (AFRRI-SR-69-14). CFSTI.

The effect of 4200 rads of pulsed gamma-neutron irradiation on the performance of a sequential behavioral task by unrestrained monkeys, Macaca mulatta, was investigated. Data were presented that demonstrate a significant decrease in accuracy and an increase in latency of response. Two types of pronounced behavioral decrements were noted within the 8 hours of postirradiation testing: incapacitation: failure to respond during a 2-minute test period accompanied by observed physical debility that occurred within the first 1.5 hours, and nonperformance: failure to respond during a 2-minute test period despite apparent physical ability to do so which occurred between 1.5 and 8 hours after irradiation. (auth)

48675 (AD-700236) EFFECT OF IONIZING RADIATIONS ON DISTRIBUTION OF PLASMA PROTEIN-BOUND NEUTRAL HEXOSES IN MICE AND DOGS. Evans, A. S. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Dec 1969. 25p. (AFRRI-SR-69-24). CFSTI.

Comparison of changes in concentration of protein-bound carbohydrates (PBC) as neutral hexoses in the plasma of C3H mice and beagles as a function of time after exposure to mixed gamma-neutron radiations revealed that the two species react similarly. The animals that died exhibited a marked increase in plasma PBC concentration while the survivors deviated only slightly from their preirradiation values. Analytical acrylamide gel electrophoresis demonstrated that distinctive, progressive postirradiation changes occurred in the plasma of the animals that succumbed. The most striking changes were in the components tentatively identified as transferrin, haptoglobins, and alpha 2-macroglobulin. Preparative fractionation of plasma of both mice and dogs by combined molecular sieving and ion exchange chromatography revealed that, in the four fractions uniformly obtained, absolute changes in PBC regularly occurred only in the first and third. The protein composition of these fractions and their significance as a prognostic tool in radiation injury are discussed. The suggestion that the preirradiation PBC concentration may constitute a crude index to radiosensitivity was confirmed under conditions specifically designed to test the hypothesis. (auth)

48676 (CEA-CONF-1553) RECOVERY AFTER ACUTE IRRADIATION UNIQUE TO THE LEVEL OF THE ORGANISM. Avargues, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 26p. (In French). (CONF-700505-3). Dep. CFSTI (U. S. Sales Only).

From 2nd Congress of the International Radiation Protection Association, Brighton, England.

Experimental data about recovery at the level of the body supplied by the split dose technique especially are analyzed, and the possibility of extrapolating to man the scheme of exponential recovery is discussed. Recovery is also considered in the case of local or highly inhomogeneous exposures. The analysis shows that recovery processes cannot be explained by cellular proliferation mechanisms only. There remains to determine the part played by humoral factors and neuroendocrine regulating mechanisms disturbed by exposure, which might account for the discrepancies noticed in different species. Such information would allow to extrapolate the results of animal experimentation to man with more reliability. (auth) (France)

48677 (COO-1653-88(Draft)) NATURE OF RADIATION INDUCED BRAIN SWELLING. Potchen, E. J.; Adatepe, M. H.; Perez, C.; Perez, B. (Washington Univ., St. Louis, Mo. Edward Mallinckrodt Inst. of Radiology). [1970]. Contract AT(11-1)-1653. 8p. Dep. CFSTI.

Brain red cell and albumin space were used to define the nature of brain swelling following brain x radiation in the 100 gram white rat. This relatively sensitive indicator of brain edema revealed a decrease in brain vascular volume at 100 to 500 rad similar to the defect seen in water intoxication. At 1,000 to 10,000 rad the decreased red cell mass was associated with a progressive (dose dependent) increase in the brain albumin space similar to the endothelial defect seen in the tin induced brain edema. Massive radiation (15,000 to 20,000 rad) resulted in an increase in both the albumin and red cell spaces, associated with frank red cell diaphoresis. Thus, brain swelling occurs at rather low radiation dose in the normal rat and the nature of the defect changes with increasing radiation dose. These observations are pre-requisite to correlative clinical studies evaluating therapeutic attempts to protect normal brain during cerebral radiotherapy. (auth)

48678 (UCSF-10-P-2-112) REGENERATION OF CELL RENEWAL SYSTEMS WITH PARTICULAR REFERENCE TO STEM CELL TRAFFIC. Patt, Harvey M. (California Univ., San Francisco. Lab. of Radiobiology). [1970]. 17p. (CONF-700610-7). Dep. CFSTI.

From 4th International Congress of Radiation Research, Evian, France.

Mechanisms involved in the regeneration of radioinduced injuries to the bone marrow are discussed. It is pointed out that little is known about the precise mechanisms involved in the initiation of regeneration after irradiation. In most cell renewal systems there is a restricted traffic of stem cells and regeneration of a damaged part requires cells of local or proximate origin. A notable exception is the lympho-myeloid complex. Yet, even here, circulating stem cells are of questionable physiologic significance in the steady state. Depending upon the circumstances of damage, marrow restitution can involve a hierarchy of stem-type cells. In respect to hematopoiesis, the possible role of a pre-stem cell ancestral to the marrow colony-forming units and resident in osseous tissue is considered. (C.H.)

48679 EFFECTS OF RADIATION ON FROG EGGS. 3. THE CYTOLOGICAL STUDY OF HEAVILY IRRADIATED EGGS. Sambuichi, Hajime (Yamaguchi Univ., Japan). Yamaguchi Daigaku Rika Hokoku: No. 19, 59-68(Mar 1970). (In Japanese).

Eggs of Rana nigromaculata, irradiated heavily with γ rays before insemination, were deprived of their ability to be fertilized. In eggs irradiated with a dose of 54,000 R, it was found after insemination that the maturation division was not activated though the sperm had penetrated normally into egg. However, these inert maturation divisions were activated normally by pricking with a glass-needle. In the eggs irradiated most heavily (108,000 R), the sperm could not penetrate into the egg after insemination and the mitotic figure of metaphase of the maturation division was distorted. These eggs were activated also by artificial stimulation and their maturation divisions were initiated. From these facts, it is suggested that physiological and cytological changes might be induced by irradiation in the egg cortex and these changes obstruct the entrance of sperm and the propagation of activating stimulation. (auth) (Japan)

48680 CHARACTERISTICS OF SHORT-LIVED MEMORY OF RATS SUBJECTED TO RADIATION TRAUMA DURING THEIR INTRAUTERINE PERIOD. Piontkovskii, I. A.; Kruglikov, R. I. (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Dokl. Akad. Nauk SSSR; 191: 218-20(1 Mar 1970). (In Russian).

Prenatal exposure to radiation leads to disturbances in the postnatal development of the brain; this may be ascertained by examining the effects on the memory. The problem was studied in rats exposed to 150 R of x radiation 16 days before birth, studying the effects of the irradiation on the short-lived memory. The experiments were carried out with animals trained in a T-shaped maze, determining the retention of traces from light and sound signals. The most characteristic feature of the higher nervous

activity of the prenatally irradiated animals was the sharp slowing down of the fixation of the conditioned reflexes; this was attributed to the reorganization of the interneural connections. (TTT)

48681 ONCOGENIC AGENTS IN THE NEOPLASTIC TRANSFORMATION IN PRENEOPLASTIC BALB/c NODULE OUTGROWTH LINES. Medina, Daniel. Berkeley, Calif.; Univ. of California (1969). 364p.

Thesis.

The effects of several oncogenic agents on the neoplastic transformation in preneoplastic mouse mammary gland cells were analyzed using a series of nodule outgrowth lines. These nodule outgrowth lines (D series) were derived from hyperplastic alveolar nodules found in aged hormone stimulated BALB/c mice free of mammary tumor virus (MTV) and nodule-inducing virus (NIV). The D series of nodule outgrowth lines were tested for their responsiveness to the following oncogenic agents: MTV, NIV, 3-methylcholanthrene (MC), 7,12-dimethylbenzanthracene (DMBA), urethan, and irradiation. Six of seven outgrowth lines responded to MTV with an increased tumor-potential. Similarly, two of three lines responded to NIV with an increased tumor-potential, and all three lines tested for their response to MC responded with an increased tumor-potential. In general, the tumor-producing capabilities of the outgrowth lines were dictated by the type of virus that infected the outgrowth lines. In addition, the responsiveness of the D series nodule outgrowth lines to MTV and to MC could not be predicted by their background tumor-producing capabilities. Irradiation and the chemical carcinogens, MC, DMBA, and urethan are effective noduligenic agents only in the presence of hormone stimulation that leads to lobuloalveolar development of the mammary gland. However, the chemical carcinogens and irradiation were effective in the nodule to tumor transformation in the absence of similar hormone stimulation. The responsiveness of outgrowth line D1 to carcinogens applied simultaneously and sequentially was tested for various combinations of the carcinogens. The data indicated that hormone stimulation enhanced the tumorigenic effect of MTV, NIV, MC, and DMBA, inhibited the effect of irradiation, and exerted no effect on urethan-induced tumorigenesis. However, the responsiveness of outgrowth line D1 to MTV and MC suggested these two agents acted additively. In a similar fashion, the tumorigenic response of outgrowth line D2 to MTV and hormone stimulation, MC and hormone stimulation, and MTV and MC, suggested these agents acted additively rather than synergistically. Carcinogen-treated D1 and D2 outgrowths were serially transplanted in order to determine if the carcinogen-induced alterations could be expressed in non-carcinogen treated hosts. The expression of carcinogen-induced alterations was dependent on the conditions of transplantation, on the carcinogen used, and on the outgrowth line used. D1 outgrowths exposed to MC, DMBA, or irradiation failed to produce a significant number of mammary tumors if transplanted as small pieces into virgin BALB/c mice. However, MC treated D1 outgrowths transplanted as whole glands onto the abdomens of untreated virgin BALB/c mice and D1 outgrowths transplanted into BALB/c mice bearing pituitary isografts produced a high incidence of mammary tumors. In addition, urethan treated D1 outgrowths and irradiation treated D2 outgrowths produced a high incidence of mammary tumors when transplanted into untreated virgin BALB/c mice. In general, these experiments indicated that exposure to one carcinogen failed to alter the susceptibility of the D1 outgrowths to a subsequent exposure to MC or MTV. The results of these experiments provide direct evidence that the oncogenic agents, MTV, NIV, MC, DMBA, urethan, irradiation, and prolonged hormone stimulation can elicit neoplastic cell variants from preneoplastic mammary gland cells. These results indicate that exposure to oncogenic agents at different times in the lifetime of a cell population can alter the tumor-producing capabilities of the cell population. (TSS) (Diss. Abstr.)

48682 RADIATION $LD_{50(30)}$ OF RICHARDSON GROUND SQUIRRELS. Markham, O. D.; Whicker, F. W.; Hansen, R. M. (Colorado State Univ., Fort Collins). Health Phys.; 18: 731-2(Jun 1970).

The 55 squirrels (which included a control group) received various exposures of whole-body irradiation from 4430 Ci ^{60}Co at 50 R/min. A summary of the survival data is given. The dose necessary to produce 50% mortality within 30 days ($LD_{50/30}$) was 1260 R. It is stated that more information on the $LD_{50/30}$ of different groups of animals must be known before a relation between the response of animals to lethal doses of radiation and their phylogenetic groupings can be determined. (UK)

48683 EFFECT OF PRIOR TRANSFUSION ON MARROW GRAFTS BETWEEN HISTOCOMPATIBLE CANINE SIBLINGS. Storb, Rainer; Epstein, Robert B.; Rudolph, Robert H.; Thomas, E. Donnall (Univ. of Washington, Seattle. Public Health Service Hospital, Seattle). J. Immunol.; 105: 627-33(Sep 1970).

Twenty-three canine littermate donor-recipient pairs were matched on the basis of histocompatibility typing with four lymphocytotoxic isoantisera. Eighteen of the 23 pairs were also tested in a one-way mixed leukocyte culture (MLC). Recipient dogs were given 1580 R whole body irradiation followed within 4 hr by infusion of marrow from the donor. Group 1 consisted of 10 recipients not given a preceding blood transfusion. Group 2 was made up of 13 dogs given a single transfusion of 100 ml of blood from the donor 10 days before irradiation. Seven of the 10 recipients in group 1 showed prompt and sustained marrow engraftment and survived beyond 70 days. Three died within 22 days of transplantation, two of marrow graft rejection and one of graft-vs-host disease. These three were mismatched with their donors in MLC. Only one of the 13 pretransfused recipients in group 2 lived beyond 70 days. Twelve dogs died within 36 days including eight that were matched by MLC as well as by serologic test. In most of these animals there was evidence of successful marrow engraftment followed by rejection. The results show that, even in histocompatible donor-recipient pairs, a single prior blood transfusion from the donor to the recipient significantly diminishes the chance of long-term survival following the marrow graft ($p < 0.01$). (auth)

48684 HISTOLOGIC EVALUATION OF OPHTHALMOSCOPICALLY SUBVISIBLE RETINAL LASER EXPOSURES. Lappin, Paul W.; Coogan, Philip S. (Air Force School of Aerospace Medicine, Brooks Air Force Base, Texas). Invest. Ophthalmol.; 9: 537-42(Jul 1970).

Four exposures of rhesus monkey macula to He–Ne laser irradiation of 6.4 mw at 100 msec produced no ophthalmoscopically visible lesions; however, microscopic lesions were detected. Of the four exposures, one produced a small burn, another had no detectable effect, and the two remaining exposures produced identical lesions consisting only of vesicular cytoplasmic swelling and depigmentation of two contiguous retinal pigment epithelial cells. The variation in effect of the irradiation is attributed to inhomogeneity of pigment granule distribution in the pigment epithelium. The exposures in this experiment were approximately 40 percent below the median effective dose for minimal ophthalmoscopically visible change. (auth)

48685 CIRCADIAN CYCLIC SENSITIVITY TO GAMMA RADIATION AS AN UNCONDITIONED STIMULUS IN CONDITIONED TASTE AVERSION STUDIES. Ternes, Joseph Wayne. Tallahassee, Fla.; Florida State Univ. (1969). 95p. University Microfilms Order No. 70-8579.

Thesis.

Four experiments were performed in order to determine whether cyclic radiosensitivity affects taste aversion conditioning in rats when ionizing radiation is used as the motivating stimulus. Experiments I and IA studied the effects of total accumulated dose and time of exposure. Total doses of 30 R and 60 R γ radiation were used to condition an aversion to saccharin. The results of these experiments indicated that radiation dose is a prime factor in conditioned saccharin aversion studies. Experiment II evaluated the relative effects of two different paradigms, trace and backward; two different interstimulus intervals, 3 hours and 6 hours; and three different radiation exposure times, 01:00 hours, 09:00 hours, and 17:00 hours. The total accumulated dose to which the Ss were exposed was 60 R. The results suggested that both the paradigm and the interstimulus interval are also powerful factors influencing the strength of conditioned aversion to saccharin. Experiment III examined the effects of habituation of stimuli in the conditioning situation by means of sham exposure trials with and without saccharin. All Ss were exposed to a total accumulated dose of 85 R. The results indicated that habituation to saccharin prior to the pairing of saccharin with radiation had a powerful mitigating influence upon the conditioning process. This experiment also indicated that habituation of other stimuli within the conditioning situation by means of sham exposure trials prior to irradiation had no appreciable effect upon the conditioning process. Both Experiments IA and II indicated that circadian cyclic radiosensitivity was a significant factor determining the extent to which the aversion was conditioned. (Diss. Abstr.)

48686 TWO MECHANISMS OF REPAIR OF ULTRAVIOLET-DAMAGED DNA IN VERTEBRATE CELLS. Regan, J. D. (Oak Ridge National Lab., Tenn.). Ann. Ist. Super. Sanita; 5: 355-9 (1969).

From Photobiology Meeting, Rome, Italy. See CONF-690552.

While pyrimidine dimers can apparently be induced in the DNA of any type of vertebrate cell in culture by uv radiation, the mechanism of repair of the dimer is highly contingent upon the type of vertebrate cell involved and upon the post-irradiation conditions. (auth)

48687 RADIATION AND THE PHAGOCYTIC FUNCTION OF THE RETICULOENDOTHELIAL SYSTEM. II. MECHANISM

OF RES STIMULATION AFTER IRRADIATION. Sijlvic, V. S. (Medical Research Council, Harwell, Eng.). Brit. J. Exp. Pathol.; 51: 140-8(1970).

Treatment of mice with bone marrow or lymph-node cells or with antibiotics partially reversed the stimulating effect of irradiation on the phagocytic activity of the reticuloendothelial system (RES) as measured by the clearance of colloidal carbon from the blood. Irradiation of the rear part of the body, including the whole abdomen, resulted in a faster clearance of carbon, but irradiation of the front part of the body failed to do so. The phagocytic activity was not altered in irradiated germ-free mice, but was markedly enhanced in irradiated conventional and specific pathogen free animals. It was concluded that irradiation facilitates bacterial invasion which causes the stimulation of the RES. (auth)

48688 CORRELATION OF ELECTROPHYSIOLOGICAL AND CONDITIONED-REFLEX CHARACTERISTICS DURING RADIATION SICKNESS. Khasabova, V. A. (Inst. of Experimental Pathology and Therapy, Moscow). Zh. Vyssh. Nerv. Deyateln. im. I. P. Pavlova, No. 6, 982-8(1969). (In Russian).

Radiation sickness was induced in monkeys by exposing them to whole-body γ irradiation (400 R, 56 to 60 R/min) after stabilization of conditioned reflexes and electrophysiological characteristics. The impairment of higher nervous activity and changes in electrical activity of the brain structures of animals revealed a phase character as radiation sickness developed. These phases of disrupted reflexes correlated well with changes in the high frequency components of cortical electrical activity. The phenomena are regarded as a reflection of the compensatory reactions of the central nervous system to the injurious effect of radiation. (JPRS)

48689 CHANGES IN THE BEHAVIOR OF RATS EXPOSED TO THE ACTION OF GAMMA RAYS IN THE SECOND HALF OF THEIR PRENATAL DEVELOPMENT. Baev, I. A.; Paskalev, Z. D. Rentgenol. Radiol.; 9: No. 1, 10-18(1970). (In Bulgarian).

Pregnant female rats were irradiated with γ rays in doses of 50 and 100 R on the 14th day of the fetal development of their young. The functional state of the nervous system of the male progeny of the irradiated rats was studied on the 57th and 60th days after birth. The characteristics of motor activity under ordinary conditions and on stimulation with light and sound were determined. Psychosensory disturbances were observed that altered in a pronounced manner the behavior of rats that were exposed to the action of γ rays during their fetal development. The extent to which neurophysiological functions were impaired was essentially the same after irradiation with 50 and 100 R. (JPRS)

48690 RADIATION AND THE PHAGOCYTIC FUNCTION OF THE RETICULOENDOTHELIAL SYSTEM. I. ENHANCEMENT OF RES FUNCTION IN X-IRRADIATED MICE. Sijlvic, V. S. (Medical Research Council, Harwell, Eng.). Brit. J. Exp. Pathol.; 51: 130-9(1970).

The rate of clearance of colloidal carbon was measured in mice up to 70 days after whole-body irradiation with supralethal doses of x rays and up to 8 weeks after exposure to mid-lethal or sublethal doses. The clearance rate was increased up to 2-fold in irradiated animals and there was a clear dose–response relation. The effect was also markedly dependent on the length of time after irradiation. It was concluded on the basis of organ uptake studies and relative numbers of carbon containing cells in liver sections that the increased rate of carbon clearance is the result of a greater phagocytic capacity of liver macrophages. A proportion of mice irradiated with 800 rads developed symptoms of secondary disease 6 weeks after the exposure which were accompanied by an increased phagocytic function of the RES. (auth)

48691 "VACCINIAL DISEASE" OF MICE. Svet-Moldavskaya, I. A.; Chimishkyan, K. I. (Research Inst. of Viral Preparations, Moscow). Acta Virol. (Prague); 13: 557-9(Nov 1969).

Infection of mice with vaccinia virus (Tashkent strain) 24 hrs after total ^{60}Co γ irradiation with a dose of 400 R resulted in a disease similar to the vaccinial disease of rats. The virus multiplied in the lungs, brain, and bone marrow. The EM-63 strain of vaccinia virus was non-pathogenic under the same conditions. (auth)

48692 EFFECT OF LOCAL ANESTHESIA ON BLOOD ELECTROLYTES IN IRRADIATED ANIMALS. Ryazantsev, V. A.; Borukhov, S. A. Eksp. Khir. Anesteziol.; 14: 73-5(Mar-Apr 1969). (In Russian).

Potassium and sodium figures in plasma and erythrocytes were studied after local anesthesia and radiation trauma. Local anesthesia resulted in decreased potassium figures in plasma and erythrocytes. The sodium titer dropped in plasma and rose slightly in erythrocytes. Acute radiation sickness during the first 24 hr depressed plasma potassium considerably and raised erythrocyte potassium. At the height of radiation sickness, potassium in the erythrocytes dropped somewhat, but remained higher than the initial figures (2.1 times). In plasma it reverted to normal. The sodium titer rose in the first 24 hr after irradiation both in plasma and in erythrocytes. It dropped somewhat at the height of radiation sickness. Local anesthesia during radiation trauma exerted no significant action on the plasma and erythrocyte electrolytes. (auth)

48693 STUDY OF THE MIGRATION OF LYMPHOCYTES OF THE BONE MARROW INTO THE THYMUS OF MICE FOLLOWING X-IRRADIATION. Gibertini, Giancarlo; Catalini, Nicola; Filoni, Sergio (Univ., Rome). Riv. Biol.; 62: 411-61(Oct-Dec 1969). (In English and Italian).

A study was made of the effects of x-rays (45° R, single exposure) on the thymus of young mice subjected to two different methods of treatment: total irradiation, and irradiation with the hind legs shielded. It was shown that the damage caused by radiation to the cortical and to the medullary lymphocytes occurs at a different moment and is of different proportions; it was also revealed that a difference exists in the recovery of these cells, both between the two thymic regions and, particularly, between the thymocytes of differently treated animals. The percentage of lymphocytic mortality was calculated and was observed to be definitely lower in the partially irradiated mice than in the other group of animals; the repopulation of the thymus occurred much later. Observations were also made of the behavior of mitotic activity that revealed the presence of cells in mitosis in the animals having their hind legs shielded; however these were not found in the other group of mice. A possible migration of lymphocytes of the protected bone marrow in the direction of the thymus, where they would begin to multiply activity, was discussed. The relationship between pycnotic lymphocytes, migration of the macrophages and volumetric changes in the Hassall corpuscles was examined. (auth)

48694 IN VITRO EXPERIMENTAL EFFECTS OF RADIO-COBALT 60 ON RABBIT POLYMORPHONUCLEAR LEUCOCYTES. Fleming, Diane Oakerson. Durham, N. C.; Duke Univ. (1969). 150p.

Thesis.

Changes in phagocytic and bactericidal ability, motility, and in the enzyme activity associated with these functions, along with a dye exclusion method for counting viable cells in non-mitotic tissue, were used to find the level of γ radiation that damaged polymorphonuclear leucocytes. Cells from a 16 hour glycogen-saline induced peritonitis in rabbits (80% heterophils) were exposed in vitro to doses of ^{60}Co γ in the supralethal range for intact animals (50,000 to 150,000 rads). Cells were tested in the first three hours following irradiation. An unencapsulated Diplococcus pneumoniae was used to measure phagocytic and bactericidal ability and, by increasing the cell metabolism, to hasten the development of any radiation-induced intracellular lesion. The per cent phagocytosis and the phagocytic index verified the ingestive ability of the individual cells; population bactericidal activity was determined by the log pour-plate dilution method for bacteria remaining in the cell-bacteria mixture following a three hour test period. The study showed that sufficient numbers of irradiated cells are capable of handling an infection when an in vitro bacterial challenge was used. (Diss. Abstr.)

48695 CHANGES IN CORONARY VESSELS OF RABBITS AFTER SINGLE LOCAL IRRADIATION OF THE CARDIAC REGION. Yakovleva, L. A.; Stepanov, R. P. (Central Research Roentgen-Radiological Inst., Leningrad). Arkh. Anat., Gistol. Embriol.; 58: No. 6, 66-9(Jun 1970). (In Russian).

Qualitative and quantitative microangiographic and histologic investigations of coronary vessels were performed in rabbits after a single local exposure of the cardiac region to a 2400 rad dose. Irradiation was found to evoke considerable myocardial changes in angioarchitectonics, increased number of open minute vessels and capillaries, these becoming congested with stasis, hemorrhages and dystrophic lesions in the walls of medium and large caliber vessels. These changes were most marked at early stages following irradiation (10 days). They became much less obvious after the lapse of 3 and 6 months, although the appearance of the vascular bed of irradiated hearts was always different from that of controls. (auth)

48696 ROLE OF THE PHAGOCYTE IN HOST-PARASITE INTERACTIONS. XX. RESTORATION OF X-IRRADIATION PHAGOCYTIC DAMAGE BY ENDOTOXIN OR POLYADENYLIC-POLYURIDYLIC ACIDS. Paul, B. B.; Jacobs, A. A.; Strauss, R. R.; Sbarra, A. J. (St. Margaret's Hospital, Boston. Tufts Univ., Boston). RES, J. Reticuloendothel. Soc.; 7: 743-53(Jun 1970).

Peritoneal exudate PMN (Polymorphonuclear leukocytes) collected from x-irradiated guinea pigs show a metabolic and phagocytic defect. Administration of bacterial endotoxin or Poly A-U complexes to the irradiated animals reverses the defect. PMN collected from x-irradiated and endotoxin or Poly A-U-treated animals have stimulated H_2O_2 production and glucose-1-^{14}C oxidation during phagocytosis similar to PMN collected from normal guinea pigs. Endotoxin administration causes a 5-fold increase in the total number of circulating PMN during leukocytosis. Repopulation may account for endotoxin restoration. Poly A-U administration does not induce a significant leukocytosis. This suggests a mechanism other than repopulation. (auth)

48697 DISC ELECTROPHORETIC PATTERN OF HISTONES FROM RADIATION-INDUCED LEUKEMIC MICE. Takeda, Atsuhiko; Takamori, Yasuhiko; Hori, Yasuharu. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 92-102(1969).

Histones from two types of radiation-induced leukemia, ascites leukemia and leukemic spleen, were compared by disc electrophoresis with those from normal spleen and thymus and Ehrlich ascites tumor cells. From these cells, whole histone, fractionated histones (f1, f2a-1, f2a-2, f2b and f3) and the other histone fractions by stepwise extraction with several concentrations of HCl-ethanol mixtures were prepared, electrophoresed in polyacrylamide gels and traced densitometrically. The electrophoretic patterns and densitometric traces showed neither whole histone nor fractionated histones and no difference between leukemic cells and normal tissues was found. With the process of stepwise extraction, nothing specific to tumor cells was found. (auth)

48698 EFFECTS OF ^{137}Cs AND ^{90}Sr ADMINISTERED CONTINUOUSLY UPON MICE. VII. LIFE-SPAN OF MICE FROM THE 11th TO 20th GENERATIONS. Nishio, Kazuo. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 90-1(1969).

The effects of ^{137}Cs and ^{90}Sr continuously administered and through generations upon the life-span of mice were described from the 11th to 20th generation. Group of mice fed with water that contained 0.004 μCi of ^{137}Cs and 0.001 μCi of ^{90}Sr per ml showed longer life-spans by 8% in males and by 15% in females. Group fed with water of which isotope concentration is ten times higher revealed 3% shorter span in males and 2% longer span in females. Group fed with water of which concentration is 100 times higher showed shorter span by 19% in males and by 10% in females. This value was obtained only about the 1st and 2nd generation because of delay in beginning of experiment. (auth)

48699 PATHOLOGIC EFFECTS OF DIFFERENT DOSES OF RADIOSTRONTIUM IN MICE. DOSE EFFECT RELATIONSHIP IN ^{90}Sr-INDUCED BORE TUMOURS. Nilsson, Agnar (Forsvarets Forskningsanstalt, Stockholm). Acta Radiol., Ther., Phys., Biol.; 9: 155-76(Apr 1970).

The dose dependency was investigated in four groups of male CBA mice injected intraperitoneally with, respectively, 1.6, 0.8, 0.4, and 0.2 μCi of ^{90}Sr/g bodyweight. A group of 95 animals was used as controls. Five mice from each group were sacrificed at certain intervals. It was shown pathologically and by conventional histologic methods that not only latency time and tumor frequency, but also type, multicentricity, location, and to some extent, the growth rate of osteosarcomas were related to the dose. The pathologic changes preceding tumor development, and their relation to the dose given, are discussed. (auth) (Sweden)

48700 PITUITARY CYTOLOGY OF RATS WITH LEYDIG-CELL TUMORS INDUCED BY LOW-LEVEL TESTICULAR IRRADIATION. Lindsay, Stuart; Nichols, C. W. Jr.; Sheline, Glenn E. (Univ. of California, Berkeley. Univ. of California, San Francisco). Contract AT(11-1)-34. Proc. Soc. Exp. Biol. Med.; 134: 523-6(Jun 1970).

The pituitary gland cytology of rats subjected to local testicular irradiation was studied. Although rats treated with 500 R x rays had a high incidence of testicular atrophy, interstitial-cell hyperplasia, and Leydig-cell tumors, increased incidences of gonadotropic hyperplasia and adenomas were not found. No statistical relationship between degenerative, hyperplastic, and neoplastic lesions of the testes and pituitary gonadotropic hyperplasia and adenomas was found. (auth)

48701 EFFECT OF SYMPATHOMIMETIC AMINES ON RADIATION-INDUCED TOLERANCE TO PENTOBARBITAL IN THE RAT. Miletich, David J.; Bradley, Sharon L.; Strike, Thomas A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Proc. Soc. Exp. Biol. Med.; 134: 403-5(Jun 1970).

Male Sprague-Dawley rats were given 250-, 500-, or 1000-rad midline tissue doses of 300 kVp x rays. Twenty-four hours post-irradiation the acute toxicity of sodium pentobarbital was determined in these animals. Rats receiving 500 and 1000 rads demonstrated an increased tolerance to sodium pentobarbital, but no change in toxicity was observed in animals given 250 rads, indicating a threshold dose of radiation is necessary to elicit this response. This radiation-induced increase in pentobarbital tolerance was similar in degree to that observed in unirradiated rats treated with amphetamine, a known barbiturate antagonist. However, when rats received amphetamine as well as 1000 rads of x rays no increased tolerance to sodium pentobarbital was observed. Four days of reserpine treatment prior to irradiation also abolished the radiation-induced increase in sodium pentobarbital tolerance. These results suggest that increased central norepinephrine levels are responsible for the radiation-induced increase in tolerance to pentobarbital. (auth)

48702 REJECTION OF SKIN ALLOGRAFTS BY RADIATION CHIMAERAS SELECTIVE GENE ACTION IN THE SPECIFICATION OF CELL SURFACE STRUCTURE. Boyse, E. A.; Lance, E. M.; Carswell, E. A.; Cooper, S.; Old, L. J. (Sloan-Kettering Inst. for Cancer Research, New York). Nature (London); 227: 901-3 (29 Aug 1970).

The experiments described were suggested by reports that chimaerism in man, cattle, mice and rats does not always guarantee the survival of skin allografts from the donor whose haemopoietic cells continue to colonize the recipient. Studies were made of chimaeras formed by protecting lethally irradiated mice with bone marrow or spleen cells, since in chimaeras of this type the recipient's haemopoietic system is totally replaced by that of the donor. Results are presented on the H-2 typing of erythrocytes and lymphocytes of chimaeras, using haemagglutination and cytotoxic tests. It was concluded that reject of skin grafts cannot be explained by genotypic differences between the donors of the grafts and the donors of the cells producing chimaerism, and it is inferred that the antigenic difference between haemopoietic cells and skin cells is phenotypic and a consequence of selective gene action. In other experiments lethally irradiated female mice were restored with female bone marrow and spleen cells and grafted 11 weeks later with female skin. Survival of the grafts was much longer and rejection more protracted. Use of the technique of acquired tolerance suggests that epidermal cells contain distinctive transplantation allo-antigens-antigens not also possessed by marrow and lymphoid cells. (UK)

48703 INFLUENCE OF TIME OF X-IRRADIATION ON THE REGENERATIVE PROCESS AFTER LOCALIZED BONE MARROW DEPLETION. Patt, Harvey M.; Maloney, Mary A. (Univ. of California, San Francisco). Proc. Soc. Exp. Biol. Med.; 133: 627-31(Feb 1970).

Studies were made of the effect of x-irradiation with 1000 R on marrow restoration after localized depletion of the rabbit femur. The femur was x-irradiated immediately before or after depopulation by dextran perfusion or 9 days later. In some experiments, the femur was x-irradiated without subsequent marrow extrusion. Regeneration was evaluated by determining the uptake of tritiated thymidine into DNA and the number of hemic cells in the depopulated and/or irradiated femoral marrow relative to the contralateral marrow. Impairment, i.e., delay of regeneration, was similar whether the femur was irradiated just before or after marrow removal. However, the radiation effect at this time was greater than that when regeneration was in progress. The response of the 9-day regenerating system resembled closely that of normal marrow. Reconstitution of the microenvironment precedes hemic cell repopulation, and it is noteworthy that a connective tissue matrix and vasculature have already been formed by 9 days after marrow removal. The difference in degree of effect with irradiation before and after regeneration has been initiated can be explained in several ways. It does not necessarily indicate a differential radiosensitivity at the cellular level. (auth)

48704 CONTENT OF SH GROUPS AND MORPHOLOGICAL CHANGES IN RAT ORGANS AFTER INTRAPERITONEAL INJECTION OF COLLOIDAL ^{90}Y AND ^{198}Au. Pavlyushchik, A. V.; Golubovich, I. A.; Makkaveeva, M. Yu.; Stankevich, M. P. (Research Inst. of Oncology and Medical Radiology, Minsk). Med. Radiol.; 15: No. 8, 54-60(Aug 1970). (In Russian).

Colloidal ^{198}Au and ^{90}Y silicate in therapeutic doses was introduced intraperitoneally to rats. The accumulation of ^{90}Y in the blood, liver, spleen, kidneys, and gonads was studied from 1 hr to 15 days after administration. A maximum accumulation was noted in 6 hr and 7 days. The greatest accumulation and morphological changes were revealed in the liver. The content of sulfhydryl groups 24 hr after ^{90}Y introduction increased in all the organs studied in comparison with the controls, however towards the 3rd day their quantity sharply decreased and did not reach the initial levels even after 15 days. (auth)

48705 THE EFFECT OF ERYTHROPOIETIN ON SURVIVAL IN IRRADIATED POLYCYTHEMIC MICE. Vittorio, P. V.;

Watkins, E. A.; Dziubalo-Biehm, S. (Defence Chemical Biological and Radiation Establishment, Ottawa). Can. J. Physiol. Pharmacol. 47: 221-3(Feb 1969).

In mice in which polycythemia was induced by transfusion, stem cell activity was almost completely suppressed, and this was accompanied by increased resistance to radiation since survival studies showed the polycythemic mouse to be more resistant to γ radiation than the normal mouse. The stimulation of stem cell activity in the polycythemic mouse with the humoral factor erythropoietin produced an increase in radiation sensitivity, as measured by survival studies. This was then followed by a more radioresistant phase as stem cell activity slowed down. Thus, in the polycythemic mouse, changes in radiation sensitivity can be brought about by a change in the state of the stem cell compartment at the time of irradiation. (auth) (Canada)

48706 EFFECT OF X IRRADIATION OF THE BONE RECEPTORS ON THE MORPHOLOGICAL COMPOSITION OF PERIPHERAL BLOOD. Alieva, M. K. (Academy of Sciences, Baku). Dokl. Akad. Nauk Azerb. SSR; 25: No. 8, 75-8(1969). (In Russian).

In order to understand the role of the interoceptive reflexes in the regulation of the morphological composition of the peripheral blood following x irradiation, the present investigation was undertaken. All of the experiments were conducted on 81 rabbits weighing 2.0 to 2.4 kg in three groups according to weight. The dynamics of the contents of erythrocytes, reticulocytes, thrombocytes, leukocyte forms, the sedimentation rate, and the percent hemoglobin were studied following x irradiation of the receptors of the periosteum of the lower part of the right femur in different doses. (tr-auth)

48707 RADIATION DOSE-INDEPENDENT INACTIVATION OF ISOLOGOUS MOUSE LYMPHOMA CELLS BY NONSPECIFIC RESISTANCE. Maruyama, Yosh; Ceman, Christopher; McHugh, Richard B. (Univ. of Minnesota, Minneapolis). Cancer Res.; 30: 2245-51(Aug 1970).

An x ray dose-independent inactivation process for LSA mouse lymphoma cells was quantitatively assessed. The process reduces survival of tumor cells at all levels of cell X-ray dosage and survivorship. In these experiments, the dose-independent inactivation constant was quantitatively determined and essentially reduced the tumor cell population at risk. This resistance appears to correspond to a nonspecific process which could neither be actively produced nor passively transferred, but which was sensitive to and reduced by whole-body irradiation. It appears to be more efficient against very small numbers of cells (one), either in a small challenge inoculum of cells or as the surviving cell in a larger number of radiation-killed lymphoma cells. (auth)

48708 BIOPHYSICAL STUDIES OF EYE LENS EPITHELIUM. Supe, S. J.; Korgaonkar, K. S. (Bhabha Atomic Research Centre, Bombay. Cancer Research Inst., Bombay). Sci. Cult. (Calcutta); 35: 524-32(Sep 1969).

Selected annular zones of the lens of rabbit eyes were irradiated using a 450 mCi ^{90}Sr-^{90}Y beta source. Collimators were placed between the applicator and the cornea. Methods for calculating absolute dose and dose ratios are described. Observations were made for a period of six months after irradiation in doses of 300 rad and for a period of ten months after doses of 1200 rad. In the low dose group, opacities began to appear within 6 weeks and began to regress within 12 weeks; at the end of 25 weeks they had completely regressed. In the higher dose group, opacities began to appear within 3 weeks and at the end of 10 months the opacities still persisted. Results indicated that radiosensitivity varied with distance from the center; the central region of the lens about 600 times more resistant than the peripheral region. (H.L.W.)

48709 MORPHOLOGICAL CHANGES IN THE LUNGS OF RATS PRODUCED BY SINGLE FIXED HOT PARTICLES (EXPERIMENTAL RESEARCH). Kitaev, E. M.; Oreshina, A. F.; Tarasov, S. I.; Yaskova, V. Z. (Central Research Inst. of Roentgen-Radiology, Moscow. Leningrad Research Inst. of Radiation Protection). Med. Radiol.; 15: No. 4, 52-6(Apr 1970). (In Russian).

The results are given of experimental study of morphological changes in the lungs of rats under the effect of single fixed hot particles. Particles of ^{60}Co of microscopic size with an activity of 10^{-9} Ci were used. The absence of focal necrosis was demonstrated at the site of fixation of a single hot particle in irradiation doses of the surrounding tissues of 10^4 to 10^5 rad during a period from 5 to 30 days. There were found some morphological changes in vessels at the site of fixation of particles and in interalveolar membranes without a definite relation to the amount of the radiation effect. (auth)

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Refer also to abstracts 48397, 48398, 48475, 48476, 48485, 48491, 48496, 48521, 48530, 48532, 48535, 48536, 48540, 48543, 48569, 48577, 48578, 48593, 48595, 48597, 48643, 48645, 48649, 48653, and 48661.

48710 (AD-704363) BIOLOGICAL EFFECTS OF LASER RADIATION. Annual Progress Report, October 1, 1968-September 30, 1969. Fine, Samuel; Klein, Edmund (Northeastern Univ., Boston, Mass. Dept. of Biophysics and Biomedical Engineering). Contract DA-49-193-MD-2436. 15p. CFSTI.

Studied and summarized were: anterior chamber measurements on CO2 corneal irradiation; corneal calcification on CO2 laser irradiation; ocular injury from CO2 laser irradiation; application of thermal models to retinal threshold injury; toxic and explosive hazards associated with lasers; pathology of internal viscera following laser irradiation; a method for detecting and measuring frequency of surface vibrations using a helium neon laser; exploration of potential carcinogenic effects of pulsed laser irradiation; lasers in biology and medicine; and rupture and tensile strength measurements of fresh and treated canine aortic tissue. (auth) (TAB)

48711 (BRH/SWRHL-70-1) LASER FUNDAMENTALS AND EXPERIMENTS. Van Pelt, W. F.; Stewart, H. F.; Peterson, R. W.; Roberts, A. M.; Worst, J. K. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). May 1970. 117p. CFSTI.

As a result of work performed at the Southwestern Radiological Health Laboratory with respect to lasers, this manual was prepared in response to the increasing use of lasers in high schools and colleges. It is directed primarily toward the high school instructor who may use the text for a short course in laser fundamentals. The definition of the laser, laser operation, properties of laser light, biological effects of laser light, laser applications, safety in classroom laser use, and experiment section (equipment necessary for experiments) are included in this manual. This manual is written in a manner to give an intuitive understanding of the device and its inherent properties. The instructor is expected to be conversant with certain of the classical elementary theories of light. (auth)

48712 PARALYSIS OF BRACHIAL PLEXUS FOLLOWING RADIOTHERAPY OF BREAST CANCER. Castaigne, P.; Laplane, D.; Augustin, P.; Degos, J.-D.; Ammoumi, J.-A. (Clinique des Maladies du Systeme Nerveux, Paris). Presse Med.; 77: 1801-4(22 Nov 1969). (In French).

When paralysis of the brachial plexus occurs in the months or years following the radiotherapy of breast cancer, two hypotheses can be suggested: invasion of the peri-nervous cellular atmosphere and eventually of the nerves themselves or damage to the nerves following the radiotherapy. The hypothesis of associated rachidian bone lesions is favored and radiographies can usually give the diagnosis. The literature concerning these two eventualities is not very abundant. The reasons for the rarity of works devoted to post-radiotherapeutic peripheral nervous lesions in clinical studies are not clear. In the discussion of a case of paralysis of the brachial plexus after surgery and irradiation of breast cancer, the diagnostic criteria are very indistinct, the better criterion appearing the duration of the evolution. This criterion is not above criticism. The long latency between the discovery and cure of the cancer and the appearance of the nervous complication is a factor. This concept needs to be made more precise. (tr-auth)

48713 ACUTE GRANULOCYTIC LEUKEMIA COMPLICATING HODGKIN'S DISEASE. Steinberg, M. H.; Geary, C. G.; Crosby, W. H. (New England Medical Center Hospitals, Boston). Arch. Intern. Med.; 125: 496-8(Mar 1970).

Cases are reported of two patients with Hodgkin's disease of long duration who developed acute leukemia. One developed refractory sideroblastic anemia that rapidly progressed to erythroleukemia. The other developed pancytopenia and died of acute granulocytic leukemia nine months later. Both had been treated with extensive radiotherapy. 6 refs. (Leukemia Abstr.)

48714 ULTRASTRUCTURE OF MYCOSIS FUNGOIDES. Brownlee, Thomas R.; Murad, Tariq M. (Ohio State Univ., Columbus). Cancer; 26: 686-98(Sep 1970).

Six biopsies from five cases of treated and untreated mycosis fungoides were studied with the light and electron microscope. The study revealed the presence of a characteristic cell type in the skin lesions. The characteristic cells had large infolded nuclei, scant cytoplasm, and few organelles. Mitochondria were clustered in one region of the cytoplasm in which the Golgi apparatus was found. Treatment with systemic corticosteroids

and electron beam therapy caused no significant change in the mycosis fungoides cells. Treatment with chemotherapy appeared to damage the malignant cells to a lesser extent than the surrounding cells. The combination of chemotherapy and x irradiation caused smoothening of the nuclear envelope, vesiculation of the endoplasmic reticulum, mitochondrial swelling, and the appearance of membrane-bound lysosome-like bodies. These changes were seen in both the mycosis fungoides cells and in other cell types present in the cutaneous lesions. No method of treatment produced necrosis in the mycosis fungoides cells. (auth)

48715 CYTOLOGY OF BLOOD AND INFLAMMATORY EXSUDATE FOLLOWING X-RAY IRRADIATION WITH SO-CALLED ANTIINFLAMMATORY DOSES. Jansa, P.; Kucera, M.; Zemanek, R. (Research Inst. of Pediatrics, Brno). Cesk. Patol.; 5: No. 1, 62-4(1969). (In Czech).

The hematological changes caused by relatively low doses of antiinflammatory therapy were evaluated. A group of 14 children, x ray treated for hypacusis (total dose of 300 R), was examined. No significant change was found in peripheral blood cell counts. A slight increase in alkaline phosphatase activity of granulocytes occurred within a few hours after irradiation. The proportion of macrophages in cells migrating into an artificial skin wound (skin window technique) was lower and the macrophages occurrence was delayed in comparison with the pre-irradiation reaction. Both these deviations from normal disappeared within one month after the end of irradiation. (NSA of Czech.)

48716 NUCLEAR HEMATOLOGICAL AND RADIOBIOLOGICAL DATA ON THE ACCIDENTAL EXPOSURE IN THE VINCA ZERO POWER REACTOR. Celander, E.; Celander, D. R.; Szimai, E. (Coll. of Osteopathic Medicine and Surgery, Des Moines). Nucl. Hematol. (Publ. Nucl. Energy); 11: 79-81(May-Jun 1970).

The nuclear hematological and radiobiological data of the accidental exposure in the Vinca "Zero Power" Reactor are reported. (auth) (UK)

48717 CLINICAL PICTURE AND DIAGNONIS OF DELAYED RADIONECROSIS OF THE BRAIN (ACCORDING TO MATERIALS FROM MEGAVOLT ROENTGENOTHERAPY OF INTRACRANIAL NEOPLASMS). Samoilov, V. I. Vop. Neirokhir.; 33: 10-6 (Nov-Dec 1969). (In Russian).

Material derived from 19 verified case records of patients with brain tumors undergoing megavolt roentgenotherapy served as groundwork for describing clinical pictures of late radio-induced necrosis of the brain and of its differential diagnosis with a tumor continuing to grow. Late radio-induced necrosis of the brain manifests itself by a slowly developing syndrome of local cerebral lesion whose projection accords with the irradiation fields, is not attended by any signs of intracranial hypertension, being characterized by the absence of shifting of roentgenocontrast markers on the craniograms and no dislocation and deformation of the ventricular system on the pneumoencephalograms. (auth)

48718 ATYPICAL CHANGES IN THYROID FOLLICULAR CELLS SECONDARY TO RADIOIODINE. Murphy S., Eduardo; Cervantes R., Q. F. B. Celia (National Commission of Nuclear Energy, Mexico City). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 724-8(Aug 1970).

In the course of the last 20 years the world medical literature has reported several instances of the difficulties of interpreting microscopic alterations in thyroid tissue when the patient had been previously treated with radioactive iodine. Nonetheless, these microscopic findings have never been adequately described or produced experimentally. It is generally felt that in the human patient they are not preneoplastic; however, in the rat, many authors have reported the production of thyroid neoplasms by the use of iodine-131. A description of the microscopic changes involved is presented and their experimental production in the rat thyroid and the significance of these alterations in human patients and in the rat are discussed. (auth)

48719 EKG-CHANGES AFTER LARGE X-RAY AND COBALT DOSES TO THE LEFT THORAX. Deli, Laszlo; Bobory, Julia; Jona, Gabor. Magy. Radiol.; 22: 48-50(Feb 1970). (In Hungarian).

The changes of the electrocardiogram were examined in 18 women during and after radiation therapy. The irradiation was given on the left thorax. In 17 patients, the radiation treatment was performed because of cancer of the left mammary gland, and in one patient because of left pulmonary carcinoma. All patients with breast cancer received post-operative x-ray therapy. One or other of the following disturbances were observed: disturbance of the axis position, of the formation of impulses, of the depolarization and the repolarization. It was found that no causal relationship existed between the EKG-changes and the radiation therapy. (auth)

48720 THE EFFECT OF IONIZING RADIATION ON THE PRODUCTION OF MALIGNANT DISEASES IN CHILDREN. II. DISTURBANCES OF OSSIFICATION IN LEUKEMIC CHILDREN. Gefferth, Karoly. Magy. Radiol.; 22: 38-42(Feb 1970). (In Hungarian).

The roentgenogram of the hand of leukemic children showed significant retardation in the development. The retardation is not due to the disease, since the patients suffered from an acute disease, existing only a short time. It was presumed that the disturbance of ossification is due to a congenital anomaly, similarly as the degenerative manifestation discussed previously. It may be that some individuals are constitutionally of lower resistance, therefore the state of their health is labile, even small stimuli may result in pathologic deviations in them. (auth)

48721 DEEP BURNS INDUCED BY X-RAYS. Ogienko, V. S. Ortop., Travmatol. Prot.; 29: 77-8(May 1968). (In Russian).

The case history of a 32-year old patient suffering from deep radiation burns is reviewed. A metal chip was removed from his hip under fluoroscopic control, exposing him to radiation for 45 minutes. After healing, the exposed area reddened and developed a blister. The patient was treated with a salve, then the epidermis was removed and the patient was given ultraviolet radiation. The wound became larger, making it necessary to hospitalize the patient again; he was treated with salves, vitamines and ultraviolet radiation. After one month of unsuccessful conservative treatment at a larger hospital, the wound and about 130 cm^2 area of the scar tissue were removed surgically under novocain anesthesia, covering the area with healthy tissue from the patient's hip. The patient recovered in two months; a check 3 years later revealed that he was able to move without any difficulty. This case indicates that operations under fluoroscopic control for the removal of foreign bodies should be carried out as fast as possible. (TTT)

48722 POSTIRRADIATION SARCOMA, INCLUDING 5 CASES AFTER X-RAY THERAPY OF BREAST CARCINOMA. Hatfield, Philip M.; Schulz, Milford D. (Massachusetts General Hospital, Boston). Radiology; 96: 593-602(Sep 1970).

Eleven cases of postirradiation sarcoma presenting over a period of fifteen years are discussed in detail. Five occurred after treatment of primary carcinoma of the breast and 3 after megavoltage therapy. Evidence is presented that these neoplasms are causally related to the precedent irradiation and are not examples of the double primary phenomenon or of spontaneously occurring osteogenic sarcoma. The frequency of postirradiation sarcoma of bone in ten-year survivors of irradiated carcinoma of the breast is estimated. The need for improved follow-up and reporting of long-term radiotherapeutic cures is emphasized. (auth)

48723 LYMPH NODE CALCIFICATION IN HODGKIN'S DISEASE. Whitfield, A. G. W.; Jones, E. L. (Birmingham Univ., Eng.). Clin. Radiol.; 21: 259-60(Jul 1970).

A patient is described in whom widespread radiological lymph node calcification has become evident 9 years after successful radiotherapy for cervico-thoracic Hodgkin's disease. (auth)

48724 RADIOLOGICAL FINDINGS IN RADIATION-INDUCED ENTERITIS AND COLITIS. A REVIEW OF 30 CASES. Mason, G. R.; Dietrich, P.; Friedland, G. W.; Hanks, G. E. (Stanford Univ., Palo Alto, Calif.). Clin. Radiol.; 21: 232-47(Jul 1970).

Following radiotherapy to the abdomen, clinically significant radiation damage may occur to the gastrointestinal tract. The disease process when observed directly (as at surgery or at autopsy) may extend far more than that seen on the radiological examination. One radiological finding is a roundish pool of barium due to many loops of small bowel being matted together and encased in a thick, fibrous capsule. Adhesions may also cause tacking down of the mucosa. These adhesions constitute a major surgical problem. Other small bowel changes include nodular filling defects, thickening, straightening and rigidity of mucosal folds, complete absence of the mucosal fold pattern, mural thickening, rigidity of the wall, strictures and functional or mechanical obstruction. Radiation changes in the large bowel may be manifested as an area of marked spasm, stricture which may be short or long, slight or severe, smooth and gently tapering, or abrupt with mucosal irregularity and overhanging edges resembling a carcinoma, ulceration, perforation and abscess formation resembling an acute diverticulitis. Many of the changes induced in the small or large bowel by radiation therapy present radiological appearances closely resembling a recurrence of the malignancy. Laparotomy and biopsy of the abdominal lesions may well be advisable in order to distinguish changes due to metastases from those due to the radiotherapy. (auth)

48725 OBTURATOR BY-PASS TECHNIQUE IN POST-IRRADIATION ARTERIAL DISEASE. Sales, J. E. L. (St. Bartholomew's Hospital, London). Proc. Roy. Soc. Med.; 63: 624-6 (Jun 1970).

A case is described of fibrosarcoma of the right adductor longus which was treated by excision and radiotherapy. An area of radionecrosis developed and was excised. Later, atherosclerosis of the arterial wall developed and an aneurysm containing a blood clot appeared. A surgical technique is described for removing the aneurysm using an iliofemoral by-pass. The post-operative progress was satisfactory. (H.L.W.)

48726 INFLAMMATION OF SKIN IN POLYCYTHEMIA TREATED BY ^{32}P. Basset, A.; Maleville, J.; Bergoend, H. Bull. Soc. Fr. Dermatol. Syphiligr.; 76: No. 1, 63-4(1968). (In French).

A case of inflammation of the skin of a male patient treated for polycythemia with ^{32}P was reported. The inflammation was completely limited to uncovered parts of the body. Some histological aspects corresponded to a subacute inflammation of the skin. The appearance of the reticular cells could be interpreted as reticulosis or a reaction to a slow inflammation. The condition did not respond to antibiotics but was successfully treated by corticotherapy. (J.S.R.)

48727 CYTOGENETIC STUDIES IN MYELOPROLIFERATIVE SYNDROME AND SOME ATYPICAL MYELOID DISORDERS. Visfeldt, J.; Franzen, S.; Tribukait, B. (Kommunehospitalet, Copenhagen. Karolinska Sjukhuset, Stockholm). Acta Pathol. Microbiol. Scand., Sect. A; 78: 80-4(1970).

Chromosome analysis of blood and bone marrow are described from a number of patients with polycythemia vera and various hematological disorders, in whom early stages of leukemia were suspected clinically. In 6 patients the bone marrow contained clone formations amounting to 32-100 percent of the cells analyzed. All patients had polycythemia vera for a number of years and were treated with repeated doses of ^{32}P orally. Three of the 6 patients died within 6 months after the chromosome analysis. The karyotypes of the clones are discussed in relation to the radiation therapy given and the development of leukemia. (auth)

48728 RADIOIDINE THERAPY TO OUT PATIENTS: THE CONTAMINATION HAZARD. Buchan, R. C. T.; Brindle, J. M. Brit. J. Radiol.; 43: 479-81(Jul 1970).

The results are given of the estimation of the activity of ^{131}I deposited in the thyroid glands of members of the households of out-patients who had received radioiodine for the treatment of hyperthyroidism. Data are given against which the significance of these results can be judged. It is suggested that, except where very young children are involved, precautions to minimize contamination should be abandoned. It is further suggested that there need be no upper limit of ^{131}I activity for out-patient treatment in so far as contamination hazards are concerned. (auth) (UK)

48729 RADIOCONTAMINATION OF THE ENVIRONMENT AND ITS EFFECTS ON THE MOTHER AND FETUS. III. PART I. RETENTION OF ^{137}Cs DURING PREGNANCY: AN INTERLABORATORIES STUDY. Sternberg J. (Univ. of Montreal); Nagai, T.; Fujimori, H.; Kimura, Y. Int. J. Appl. Radiat. Isotop.; 21: 351-62(Jun 1970).

The determination of ^{137}Cs and ^{86}Br in human placentas was carried out in different laboratories in Japan and Canada in order to standardize the radioassay procedures. Placentas from normal term deliveries were collected and measured for a period of 12-16 months in the Tokyo and Osaka areas in Japan and in the Montreal area in Canada. Two procedures required the ashing of the entire placenta prior to radioassay. In the Tokyo group, the ashed organ was placed in a two NaI crystal system, in an almost 4π geometry, and the γ radiation was measured. The Osaka group continues the chemical separation of cesium by precipitation with chloroplatinate; the β radiation is then further measured with an anticoincidence system. These procedures are not adequate for a large series of measurements, since the ashing of the placenta is time-consuming and frequently leads to errors due to loss of material during the ashing. Another procedure avoids the ashing and compresses the fresh placentas to a semi-dry cake; the method is more rapid and avoids losses of radionuclides or radiocontamination during the manipulation. The samples are then measured in a two NaI crystal system with a geometry close to 4π. The average content of ^{137}Cs is closely similar in Japanese and Canadian placentas, regardless of the differences in the dietary habits and potassium intake in the two racial groups. However, some organs exhibit a markedly higher level, sometimes 3-4 times the average of 23-24 μCi/kg tissue; even at this concentration, the total amount of placental ^{137}Cs accounts for only a small fraction of the irradiation produced by ^{40}K in the same organ. The amount of absorbed energy produced by both radionuclides is well below the danger level. These data compare well with the former measurements in placentas obtained from women of the Hiroshima region, some of whom were in that city during the war. (auth) (UK)

48730 AGE-DISTRIBUTION OF CANCERS CAUSED BY OBSTETRIC X RAYS AND THEIR RELEVANCE TO CANCER LATENT PERIODS. Stewart, A. M.; Kneale, G. W. (Oxford Univ.). Lancet; 2: 4-8(4 Jul 1970).

The age-distributions of 5802 children with spontaneous or idiopathic cancers and 1045 children who were x-rayed in utero before cancer developed were compared. The comparisons revealed 423 extra x-rayed cases, 20 of which were ascribed to cerebral tumors diagnosed within a few weeks of birth after threatening to obstruct labor. The remaining 403 cases were probably caused by the radiations, and thus had latent periods that corresponded to the age when symptoms developed. These radiogenic cases were evenly distributed between ten diagnostic groups and had latent periods that not only varied with the type of cancer but also implied continuous growth of the tumors from the dates when the x-rays were taken. The relevance of these findings to adult cancers is discussed in terms of the gene-selection theory and in relation to the observation that latent periods for childhood and adult leukemias are not significantly different. (auth) (UK)

48731 RADIATION DOSE EFFECTS IN RELATION TO OBSTETRIC X-RAYS AND CHILDHOOD CANCERS. Stewart, Alice; Kneale, G. W. (Oxford Univ.). Lancet; 1: 1185-8(6 Jun 1970).

Epidemiological data from the Oxford Survey of Childhood Cancers were analyzed in respect to in-utero exposure to x-rays during obstetric investigations. The risk of cancer was greatest when exposure was during the first trimester. The excess cancer risk from obstetric x-ray examination was directly related to the fetal dose. It is suggested that this dose-response relationship fits in with a previously published hypothesis that cancers caused in this way are due to the propagation of one cell whose controlling gene experienced a small but irreversible change at the moment of exposure to x-rays. (auth) (UK)

48732 CEREBRAL RADIOSURGERY. II. AN ANATOMIC STUDY OF GAMMA RADIOLESIONS. Wennerstrand, Jan; Ungerstedt, Urban. Acta Chir. Scand.; 136: 133-7(1970).

A histological study is presented of gamma radiolesions obtained in 9 patients in whom brain lesions were made by single irradiation with narrow beams of gamma rays from ^{60}Co. The lesions are predictable and well circumscribed and the histological appearance is highly uniform. (auth) (SW)

48733 DYNAMICS OF VASOMOTOR DISTURBANCES IN X RAY THERAPY OF NEUROENDOCRINE METABOLIC FORMS OF AFFECTION OF THE HYPOTHALAMIC REGION. Kryzhenko, T. V. Med. Radiol.; 15: No. 1, 23-7(Jan 1970). (In Russian).

The present investigation was designed to study the dynamics of the vasomotor disturbances following x-ray therapy of the neuroendocrine-metabolic form of disease of the hypothalamic region. Also, clinical investigations of the autonomic nervous system of animals were conducted including the indexes of arterial pressure in the brachial and temporal arteries using arterial oscillography of the shoulders and tibia, skin thermometry, radiography of the temporal regions, supraorbital and radial arteries, and the application of stimuli to the different levels of vascular regulation (hypothalamic, cortical), for which two stimuli were used: cold (+4°C) and reflex time. Twenty-five patients with the neuroendocrine-metabolic form of disease of the hypothalamic region were observed. The majority constituted women (18 women, 7 men) and ages ranged from 20 to 40 yrs. The length of illness varied from 1 to 20 yr. (tr-auth)

48734 EFFECTS OF POSTOPERATIVE COBALT IRRADIATION ON THE HEART IN BREAST CANCER. Nakagawa, Kyoichi; Kubo, Kanji (National Hospital of Nagoya, Japan). Shinzo; 1: 1163-72(Nov 1969). (In Japanese).

A comparative study was made of preoperative electrocardiograms and those taken immediately following postoperative telecobalt irradiation in patients with breast cancer to investigate the cardiac effects of postoperative radiotherapy. The broad treatment categories of the 77 subjects consisted of: 35 patients given tangential irradiation with a dose of 5,100 R (19 patients on the left breast and 16 on the right); 12 patients received parasternal irradiation with 6,000 R (vertical irradiation centered around the sternum irrespective of the side of cancer); 10 patients with progressive cancer given single treatment with tangential telecobalt irradiation; and 20 surgical cases given no radiotherapy. The variation in T wave pattern (V_1-V_6) suggesting damage in the anterior wall of the heart was observed in 74% of the patients treated with left tangential irradiation in contrast to 25% of the right irradiation. With parasternal irradiation, T wave abnormality (mainly V_1 and V_2) was observed in 67% of the patients. Follow-up studies made of 10 cases treated with left tangential irradiation indicated the accelerated abnormal pattern of T wave with left side expansion in half of the cases. It was indicated that post-

operative irradiation performed for preventive purpose causes some cardiac disorders which are not necessarily transitory. (NSA of Japan)

48735 POST-RADIOTHERAPEUTIC LATE DIFFUSE ALOPECIA WITHOUT CLINICAL RADIODERMATITIS. Rollier, R. Lyon Med.; 233: 464(15 Feb 1970). (In French).

Delayed diffuse post-radiotherapeutic alopecia is frequent in Morocco where 30 to 35% of the children are afflicted with scalp disease and radiotherapy was properly carried out. Although no area of sclero-atrophic radiodermatitis is observed, delayed pathognomonic capillary changes were found eight to ten years after radiotherapy. (auth) (France)

48736 LATE SEQUELAE OF THERAPEUTIC IRRADIATION FOR BENIGN CONDITIONS IN CHILDHOOD. Fendel, H. (Univ., Munich); Feine, U. Ann. Radiol.; 13: R-291-6(1970). (In English and French).

Results of the long-term evaluation of 1301 individuals who were treated during their childhood with ionizing radiations to the skull, face, cervical or thoracic regions for benign inflammatory conditions were presented. Of these groups, 75% could be traced. At the time of inquiry, 162 were dead: 40% of these died of problems related to the original condition for which they had received radiotherapy. Among the 817 surviving individuals, the average duration of follow-up was 21.6 years. The authors did not find a single case of leukemia or cancer of the thyroid. When the thyroid was near the irradiated volume, however, a number of patients developed goiter. The goiter appeared, on the average, 17 years after irradiation. There was a correlation between occurrence of goiter and dose delivered. Aside from this effect on the thyroid and its relationship to irradiation, the dose delivered to the gonad in the course of irradiation was determined. They found no modification in the distribution of sexes in the offspring of irradiated women. For small doses of ionizing radiations, it is very difficult to establish quantitative bases for long-term risk. (auth) (France)

Radiation Effects on Plants

Refer also to abstracts 48390, 48401, 48412, 48417, 48422, 48477, 48480, 48481, 48483, 48489, 48494, 48495, 48497, 48498, 48501, 48502, 48504, 48507, 48514–48516, 48518–48520, and 48522.

48737 (TID-25486) EFFECTS OF IONIZING IRRADIATION ON THE XYLEM DERIVATIVES OF PINUS ECHINATA MILL. Bulletin 567T. Clark III, Alexander; Hamilton, J. R. (West Virginia Univ., Morgantown. Agricultural Experiment Station). Jun 1968. Contract AT(40-1)-3400. 16p. Dep. CFSTI.

The effects of in vivo exposure of pole size Pinus echinata Mill. to a flux of mixed gamma and slow-neutron radiation were assessed in terms of three-cell morphological characteristics and strength in tension parallel to the grain. Four study trees were exposed to 900 rads in June, 1959 and 1,400 rads in August, 1960, at the Georgia Nuclear Laboratories near Dawsonville, Georgia. The trees were sampled at several heights up to approximately 80 per cent of total height on the side facing the reactor and the side diametrically opposite. Specimens were prepared from the two zones of xylem formed during irradiation and from equivalent locations in the increment which preceded irradiation. The latter specimens served as controls. The irradiated tissues in the 1960 increment were 27 per cent weaker in tension parallel to the grain, the walls of tracheids were 16 per cent thinner, and the lumina were 31 per cent larger than those of the controls. No significant change due to irradiation was noted in fiber length in 1960 nor in any of the variables in 1959. The August, 1960 irradiation caused aberrations which were located in the latewood of the 1960 increment at all height levels investigated. In contrast, the aberrations associated with the June, 1959 irradiation period were located in the latewood in the lower levels of the bole but in the early-wood of the upper levels. The degree of radiation-induced aberration did not vary with location in the bole. There was no significant variation due to height or side. (auth)

48738 WOODY PLANTS: CHANGES IN SURVIVAL IN RESPONSE TO LONG-TERM (8 YEARS) CHRONIC GAMMA IRRADIATION. Sparrow, Arnold H.; Schwemmer, Susan S.; Klug, E. Eric; Puglielli, Leanne (Brookhaven National Lab., Upton, N. Y.). Science; 169: 1082-4(11 Sep 1970).

The number of plant deaths which occurred over 8 years of chronic gamma irradiation (20 hours/day) of 11 species of woody plants indicated a decline in the rate of death with increasing exposure time. This suggests that a highly effective repair system may develop, at least in the range of exposure which reduces survival by 50 percent. The inverse relationship previously found between interphase chromosome volume and radiosensitivity for single 16-hour exposures was confirmed for chronic exposures by construction of appropriate regressions. Radiosensitivity of a species can be predicted from these regressions if the interphase chromosome volume is known. The distributions of interphase chromosome volumes and predicted sensitivities are given for 215 species of woody plants. (auth)

48739 γ-IRRADIATION TO MUSHROOMS. 1. EFFECT OF γ-IRRADIATION ON THE STABILITY AND ACTIVITY OF NUCLEIC ACID RELATED SUBSTANCES AND ENZYMES IN MUSHROOMS. Mouri, Takenori; Hata, Keiko; Terada, Junko; Hashida, Wataru (Toyo Junior Coll. of Food Tech., Hyogo, Japan). Hakko Kogaku Zasshi; 48: 301-6(May 1970). (In Japanese).

The fungi Psalliota bisporus and Lentinus edodes were irradiated with γ rays of 5 to 50×10^5 rad, and changes of nucleic acid related substances were investigated by means of chromatography with a Dowex 1×8 column. Adenosine triphosphate in the fungi disappeared at a dose of 5×10^5 rad, whereas ADP remained as much as the initial amounts. Changes in the amounts of mononucleotides were negligible. Preliminary experiments were carried out on the extractability of nucleic acid related enzymes from mushrooms. Extracted enzyme solutions from P. bisporus were subjected to γ irradiation; as a result, their ribonuclease, phosphodiesterase, and phosphomonoesterase activities remained moderate even at a high dose of 5×10^5 rad. It seems reasonable to consider that there is a possibility of the breakdown of nucleic acid related substances during storage by the actions of the enzymes that have remained after the γ irradiation. (Japan) (TSS)

48740 EFFECT OF X-RADIATION ON THE CONCENTRATION OF SCOPOLIN AND CAFFEOYLQUINIC ACIDS IN TOBACCO. Koeppe, D. E.; Rohrbaugh, L. M.; Rice, E. L.; Wender, S. H. (Univ. of Oklahoma, Norman). Radiat. Bot.; 10: 261-5(Jun 1970).

Eighty-day-old tobacco plants were irradiated with 100 R, 2500 R, and 4400 R of x radiation, harvested 12, 21, and 29 days after treatment, and analyzed for chlorogenic acid, neochlorogenic acid, 4-0-caffeoylquinic acid ("band 510"), and scopolin. Dose dependent, post-irradiation accumulations of scopolin were observed in both young and old leaves. In roots and stems, scopolin concentrations first increased to 1.5 to 10 times that of comparable controls, and then declined in later harvests to levels below that of controls. Accumulations of caffeoylquinic acids were variable. Young leaves formed after treatment with 1000 R were twisted, malformed and contained lower caffeoylquinic acid concentrations on a fresh weight basis. Alternative speculations are discussed which could account for scopolin accumulations and the implications thereof. (auth) (UK)

48741 RADIOSENSITIVITY OF GYMNOSPERMS. II. ON THE NATURE OF RADIATION INJURY AND CAUSE OF DEATH OF PINUS RIGIDA AND P. STROBUS AFTER CHRONIC GAMMA IRRADIATION. Bostrack, J. M.; Sparrow, A. H. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot.; 10: 131-43(Apr 1970).

Various measurements of and observations on the effects of chronic γ irradiation of Pinus rigida and P. strobus were made and analyzed. Pinus rigida was exposed for a period of 17 to 18 yr and P. strobus for 7 yr. Both species showed severe inhibition of growth leading to ultimate death of some trees at daily exposure rates of 6 R/day and lower. At the end of the exposure periods, average length of mature needles of trees receiving the higher exposure rates was less than one-half that of needle lengths of unirradiated trees. The reduced growth of branches and needles and premature shedding of needles yielded a greatly reduced amount of photosynthetic tissue, resulting in small sparse crowns. Such trees had a characteristic appearance similar to that in non-irradiated trees growing under highly unfavorable conditions. In ten-year-old P. strobus trees exposed to about 6 R/day for 7 yr, the dry weight of needles on surviving trees was reduced by 75% over controls. In P. strobus exposure rates of 1 to 2 R/day resulted in a statistically significant (at the 5% level) increase in tree height and mature needle length. Needle dry weight also showed an increase at low exposures though these data were not subjected to statistical analysis. The growth habit and aging process of unirradiated trees competing for raw materials and space within a forest community were compared to the syndrome of chronically irradiated P. rigida and P. strobus trees. The authors propose that the slow decline and eventual death of chronically irradiated trees as well as unirradiated ones growing under other conditions of stress probably result from slow starvation, brought about by a critical reduction in the amount of photosynthetic tissue. (auth) (UK)

48742 COMPARISON OF UV-INDUCED DELAY IN GERMINATION IN PIGMENTED AND PIGMENT-INHIBITED CONIDIA OF ASPERGILLUS CARBONARIUS. Curtis, C. R. (Univ. of Maryland, College Park). Radiat. Bot.; 10: 125-30(Apr 1970).

The normally black-brown pigmentation of Aspergillus carbonarius conidia was greatly reduced when the organism was

grown on media containing either dimethyl sulfoxide, dimethyl sulfone, or dimethyl sulfite at a concentration of 5000 ppM. The loss in pigmentation did not affect conidial germination and was accompanied by a sharp loss in uv resistance as measured by the germinability of the conidia after various doses of far-uv irradiation. Semi-logarithmic plots followed a linear relation after an initial shoulder at low doses. Germination delay was partially overcome in both pigmented and pigment-inhibited conidia if post-treatment near-uv irradiation was given, however, a greater relative recovery was found in pigment-inhibited conidia. (auth) (UK)

48743 TEMPERATURE CHANGE AS THE CAUSE OF RADIO FREQUENCY RADIATION EFFECTS ON CHLORELLA PYRENOIDOSA. Barchi, Robert; Gray, Irving (Georgetown Univ., Washington, D. C.). Physiol. Chem. Phys.; 2: 263-73 (1970).

Recent studies have shown that cell growth can be affected by radio frequency (rf) radiation. Chlorella pyrenoidosa was exposed to 14 megahertz rf fields at four power levels: milliwatts, 75, 200, and 1200 watts. There was no alteration in cell growth at the low power level. At 75 watts there was no change in growth after exposure up to 8 hours. The temperature of these samples rose only to 28°C. At 200 watts, the temperature rose to 45°C. When the temperature rose above 32°C, a reversible inhibition of growth was observed. At 1200 watts, the absorption of rf radiation caused an increase in temperature to above 53°C, related to the composition of the medium, size of culture, and volume. At this power level, as little as 6 minutes exposure arrested growth, however, only when the temperature reached 53°C was cell growth stopped. Similar results were obtained with temperature alone. It is proposed that the effects of rf radiation are the result of temperature increase resulting from the absorption of the energy. (auth)

48744 DARK RECOVERY OF SACCHAROMYCES AFTER UV- OR X-IRRADIATION: THE EFFECT OF CELL CONCENTRATIONS AND OF DIMETHYL SULFOXIDE AND SOME DYES. Umlauf, C.; Stein, W.; Pietsch, L.; Lochmann, E.-R. (Freie Univ., Berlin). Biophysik; 6: 275-9(1970). (In German).

For small cell concentrations during reactivation time the effect of dark recovery (liquid holding recovery) after uv or x irradiation was low. The effect was much greater cell concentration. Dimethyl sulfoxide prevented dark recovery after uv or x irradiation. Some dyes similar to thiopyronine did not show an effect. (auth)

48745 RECOVERY OF THE MITOTIC INHIBITION INDUCED BY X-RAYS AND POLYPLOIDY IN SOME SOLANUM SPECIES. Kowyama, Yasuo; Yamagata, Hirotada; Hori, Shiro. Annu. Rep. Radiat. Center Osaka Prefect.; 10: 76-80(1969).

Mitotic inhibition and chromosomal aberration induced by 500 R of x-rays in root-tip cells of three Solanum species different in ploidy were examined for 9 hours after irradiation at one hour intervals. Mitotic Index (M.I.) reached the minimum value at 1 to 2 hours after irradiation in all three species, and recovered to the control value at 8 hours, 7 hours, and 5 hours after irradiation in the diploid, tetraploid and hexaploid species, respectively. From the results, it was concluded that higher polyploid was more resistant to mitotic inhibition. It was also observed in S. melanocerasum that the frequency of cells with chromosome bridges showed a peak at 1.5 hours after irradiation and began to increase again at 6 hours after irradiation. Experimental results suggest that irradiation of cells in G_2 phase gives rise to both remarkable aberration of chromosome and inhibition of mitosis, while cells in S phase are rather resistant to mitotic inhibition, involving only chromosomal aberration. (auth)

48746 CHEMICAL RADIOPROTECTION IN THE ABSENCE OF THE NUCLEUS IN ACETABULARIA MEDITERRANEA. Netrawali, M. S. (Univ. Libre, Brussels). Radiat. Bot.; 10: 365-70(Jul 1970).

Cells of Acetabularia mediterranea were found to be equally sensitive to γ radiation in the presence as well as in the absence of the nucleus regarding growth and morphogenesis. Pretreatment with 2-β-aminoethylisothiourea (AET) can protect the cells from radiation damage: this is reflected by a partial reversal of the inhibition in growth and morphogenesis due to radiation. The absence of the nucleus does not modify the protection afforded by AET. Radiation doses that inhibit the growth and morphogenesis also interfere with the increase in cytoplasmic DNA. The inhibition is of the same order of magnitude in irradiated nucleate and anucleate cells and it is less in AET treated cells. (auth) (UK)

48747 RECOVERY FROM CELLULAR DAMAGE IN VEGETATIVE SHOOT APICES OF CAPSICUM ANNUUM L. AFTER ACUTE GAMMA IRRADIATION. Iqbal, Javed (Panjab Univ., Lahore). Radiat. Bot.; 10: 337-43(Jul 1970).

Seedlings of Capsicum annuum were irradiated with acute γ rays (^{60}Co) at cotyledonary, 4-leaf, 8-leaf, and 12-leaf stages of development. They were exposed to doses of 1, 2, 3, 4, 5, 7.5, and 10 kR. The responses of shoot apices subsequent to radiation damage were studied. Following a dose of 1 to 2 kR, resumption of normal growth can take place by direct recovery of the shoot meristem. In this case enlargement of cells surrounding the damaged area fills the gap left after the disorganization of the damaged cells. In a few cases, recovery takes place either by the development of new meristematic centers at the apex or by the formation of an adventitious meristem well below the damaged apical meristem. Depending upon the number and position of meristematic centers the main apex may be reconstituted, dichotomized, or fasciation may result. No recovery takes place at the higher exposures of 4 to 10 kR. It is concluded that the percentage of cell deaths at different exposures determines the various ways in which a normal pattern of organization and growth of the shoot apex is restored. (auth) (UK)

48748 EFFECTS OF MICROIRRADIATIONS ON THE MICROSPOROCYTES AND MICROSPORES OF TRADESCANTIA PALUDOSA. II. ALPHA PARTICLES. Garot, G.; Tilquin, J. P.; Gilles, A. (Univ. Catholique, Louvain, Belg.). Can. J. Genet. Cytol.; 12: 137-44(Mar 1970). (In French).

Alpha-irradiations of Tradescantia paludosa meiocytes cultivated under the microscope are performed with micro-needles plated with ^{210}Po. Injuries on chromosome and spindle are analyzed in both meiotic divisions by phase-contrast observation. (auth) (Canada)

48749 TEMPERATURE DEPENDENCE OF MORTALITY RATE OF RADIOSENSITIVE STRAINS OF E. COLI AND S. CEREVISAE. Matsumoto, Shinji; Kagami-Ishi, Yoshiko (National Inst. of Radiological Sciences, Chiba, Japan). Jap. J. Genet.; 45: 153-60(May 1970). (In Japanese).

Life times of radiosensitive strains of Escherichia coli and Saccharomyces cerevisiae were obtained with logarithmic and stationary phase cells at various temperatures. The results of temperature dependence of mortality rate were well described by the first order chemical reaction formula (Arrhenius equation). In the case of E. coli JC 1569 b rec$^-$ and its original rec$^+$ strains, the difference in survival curves between them appeared only in logarithmic phase cells and was described as a difference in energy independent term in the Arrhenius equation. These results have suggested that these rec$^+$ and rec$^-$ strains have a recovery mechanism but the rec$^-$ strain could not repair the damage enough to survive during exponential growth and/or tolerate the injury for a subsequent DNA replication and growth. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 48391, 48396, 48399, 48404, 48414 48487, 48488, 48493, 48499, 48500, 48509—48512, 48517, 48691, 48749, 48771, 48777, and 48790—48792.

48750 (ISS-69/38) SPECTRAL MODIFICATIONS IN UV IRRADIATED SOLUTIONS OF T_1 PHAGE DNA. Cremonese, M.; Giampaoli, C.; Matzeu, M.; Onori, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 22 Sep 1969. 30p. Dep. CFSTI (U. S. Sales Only).

The modification produced by UV radiation on the native DNA of the T_1 phage is studied. The spectral modifications produced in the absorption spectra of the irradiated solutions are presented. At most these modifications reach values of ~10%. A lowering of the O. D. in the wavelength range $2400 < \lambda < 3000$ Å is observed with a maximum at $\lambda \simeq 2700$ Å; it corresponds to the disappearance of the thymine molecule. There is an increase of the O. D. at $\lambda > 3000$ Å, which indicates the presence of photoproducts with an absorption maximum at $\lambda = 3250$ Å. From the interpretation of the spectra, the formation of thymine dimers and of another photoproduct can be seen. For low doses of radiation the thymine dimers are predominant but at high doses the opposite occurs. Cross-sections for photoproduct formation at the wavelengths of irradiation are studied. (auth)

48751 (STI/PUB-168) MICROBIOLOGICAL PROBLEMS IN FOOD PRESERVATION BY IRRADIATION. Panel Proceedings Series. Report of a Panel Held in Vienna, 27 June-1 July 1966. (International Atomic Energy Agency, Vienna (Austria)). Nov 1967. 156p. (CONF-660674). IAEA $3.00.

Separate abstracts were prepared for the 14 papers in this symposium. (E.R.B.)

For abstracts of individual papers see: 48422, 48761–48770, and 48789–48791.

48752 EFFECT OF GAMMA RADIATION ON THE METABOLIC PATHWAYS IN THE SYNTHESIS OF TRIMETHYLAMINE BY PSEUDOMONAS ERYTHRA. Reddy, Gollamudi V. Baton Rouge, La.; Louisiana State Univ. (1969). 119p. University Microfilms Order No. 70-9084.

Thesis.

The metabolic changes induced by low-dose γ irradiation (200 krad) of Pseudomonas erythra in the production of trimethylamine were studied. The products which play an important role in the production of trimethylamine are: amino acids, choline, ethanolamine, and pyridoxine. Quantitative determination of these compounds were made at 0, 5, 10, 15 and 20 days of incubation. The treatment combinations used in the determinations are reported. (Diss. Abstr.)

48753 FACTORS AFFECTING CELLULAR PHOTOSENSITIVITY. Proceedings of the Photobiology Meeting Held at Rome, Italy, 8th May, 1969. Castellani, A. (ed.). Ann. Ist. Super. Sanita; 5: 309-85(1969). (CONF-690552).

Separate abstracts were prepared for the eight papers appearing in these proceedings. (E.R.B.)

For abstracts of individual papers see: 48406, 48593, 48594, 48686, and 48754–48757.

48754 IN VIVO DEMONSTRATION OF REPAIR REPLICATION. Hanawalt, P. C. (Stanford Univ., Calif.). Ann. Ist. Super. Sanita; 5: 311-17(1969).

From Photobiology Meeting, Rome, Italy. See CONF-690552.

The repair mode of replication is nonconservative since there is no net increase in the amount of DNA but rather a removal and replacement of parental material. It is also semiconservative in the sense that the parental single-strand region opposite the damaged region is conserved. A combined labeling technique for the in vivo demonstration of repair replication is described. It involves the combined labeling of replicating DNA with a density label and a radioactive label. The use of a density label such as 5-bromouracil and a radioactive label permits the determination of the incorporation of this label into small regions of the parental DNA. Repair replication was first demonstrated following uv irradiation of bacterial cells, but has since been observed following the action of x rays, nitrogen mustard, nitrosoguanidine, mitomycin C, and methylmethanesulfonate. Generalities regarding repair replication and details of the process are discussed. (E.R.B.)

48755 ENZYMATIC MECHANISMS FOR THE REPAIR OF UV IRRADIATED DNA. Grossman, L.; Kaplan, J.; Kushner, S.; Mahler, I. (Brandeis Univ., Waltham, Mass.). Ann. Ist. Super. Sanita; 5: 318-33(1969).

From Photobiology Meeting, Rome, Italy. See CONF-690552.

Two enzymes that can recognize localized regions of distortion in damaged DNA are capable, together, of excising photoproducts from uv-irradiated DNA. One of the enzymes is an endonuclease that causes a single phosphodiester bond break 5′- to and imminent to each pyrimidine dimer thus creating a single-stranded region with a 5′-hydroxyl end. Following this incision step, the second enzyme, an exonuclease, excises the damaged region by degrading the exposed single-stranded region arising from the incision step. The combined action of the two enzymes results in the release of acid-soluble nucleotides containing thymine–thymine dimers. The isolation and purification of the enzymes, their properties, and the mechanisms of their action on DNA are discussed in detail. (E.R.B.)

48756 REPAIR FROM UV DAMAGE IN E. COLI AND M. LUTEUS. van de Putte, P. (National Defense Research Organization TNO, Rijswijk, Netherlands); van Sluis, C. A. Ann. Ist. Super. Sanita; 5: 334-40(1969).

From Photobiology Meeting, Rome, Italy. See CONF-690552.

The UVR-type mutants of Escherichia coli are uv-sensitive. They are unable to repair uv damage in both cellular and phage DNA because of inhibition in the excision process. The Micrococcus luteus mutant ML9 lacks the uv-specific endonuclease required for excision of DNA dimers, hence it can not repair uv damage in vitro. However, the strain is highly uv-resistant. The role of the genotypes involved in the UVR-type mutants of E. coli was investigated in recombination experiments and the results are discussed. The mechanism by which uv damage is repaired in the ML9 strain of M. luteus when the uv-specific endonuclease is lacking is discussed on the basis of current experimental data. (E.R.B.)

48757 DNA REPAIR PROCESSES IN ESCHERICHIA COLI: STUDIES WITH MUTANTS DEFECTIVE IN GENETIC RECOMBINATION. Emmerson, P. T. (Institut du Radium, Paris). Ann. Ist. Super. Sanita; 5: 341-54(1969).

From Photobiology Meeting, Rome, Italy. See CONF-690552.

Recombination deficient (Rec⁻) mutants of Escherichia coli are sensitive to both uv and x irradiation, presumably because they are defective in ability to repair radiation damage in their DNA. They appear to fall into two classes, those carrying recA, a mutation that maps between cysC and pheA, and those carrying either recB or recC, which both map between argA and thyA. Strains carrying recA break down their DNA excessively following exposure to either uv or x irradiation while those carrying recB or recC are deficient in this process. The uv-sensitivity of the double mutants uvrA recA and uvrB recB indicate that the processes controlled by recA and recB are to a considerable extent independent of the cut and patch process for the removal of photoproducts in which the uvr^+ genes participate. This may indicate the presence of another repair process, referred to as the recombinational repair process, that requires the cell's machinery for genetic recombination. Strains carrying recB are deficient in an ATP-stimulated exonuclease and several possible roles for this nuclease in repair processes are considered. The nature of the defect in recA mutants is not yet known. The survival of the function of the lac^+ gene in an irradiated $Flac^+$ episome which is transferred to an unirradiated F^- strain by conjugation is greatly increased by the presence in the recipient strain of $recA^+$. Many of the Lac^+ conjugants produced in this cross are unable to act as secondary donors, which suggests that they may be recombinants in which part of the episome is incorporated into the F^- chromosome. (auth)

48758 EFFECT OF GAMMA RADIATION ON SERRATIA MARCESCENS. STUDIES ON THE RADIOSENSITIVITY OF PRODIGIOSIN PRODUCTION. Bartlett, William T.; O'Donovan, Gerard A.; Neff, Richard D. (Texas A and M Univ., College Station). Radiat. Res.; 43: 196-203(Jul 1970).

The effects of ^{60}Co γ radiation on the production of the red nonessential tripyrrole pigment, prodigiosin, were studied in Serratia marcescens. A comparison of the survival of pigmenting and nonpigmenting strains of S. marcescens was carried out. Wild-type S. marcescens, Nima, which synthesizes prodigiosin, and three nonpigmenting mutant strains were examined. Measurement of colony-forming ability after γ radiation was always greater in nonpigmenting (white) mutants of S. marcescens than in pigmenting strains. The red pigment may be acting as an endogenous radiosensitizer. (auth)

48759 INACTIVATION OF SALMONELLA IN POULTRY WITH GAMMA RADIATION. Licciardello, J. J.; Nickerson, J. T. R.; Goldblith, S. A. (Massachusetts Inst. of Tech., Cambridge). Poultry Sci.; 49: 663-75(May 1970).

The radiation resistance of several Salmonella serotypes was determined in poultry meat under various conditions. Under anaerobic conditions the decimal reduction dose (about 70 krad) was 2.8 times greater as compared to aerobic conditions. The initial concentration of cells did not affect the radiation inactivation rate. Radiosensitivity of the cells increased as the irradiation temperature increased from −17.7°C to 46°C. There was no difference in radiation resistance between laboratory strains of Salmonella and wild strains isolated from poultry. During a 28 day storage period at refrigerator temperature there was no significant reduction in the salmonellae population surviving an irradiation treatment in chicken meat. At room temperature storage the survivors of irradiation did not grow at a faster rate on poultry compared with unirradiated controls. For a hypothetical irradiation treatment of 300 krad it was estimated that the frequency of contamination with Salmonella would be reduced to not more than one contaminated bird in 80,000. (auth)

48760 MODIFYING EFFECTS OF IR LIGHT ON THE RECOMBINATION PROCESS IN THE X-IRRADIATED ESCHERICHIA COLI. Turbina, L. N. (Inst. of Genetics and Cytology, Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 3, 116-8(1970). (In Russian).

The influence of combined effects of x-rays of 1000 rad and infrared radiation with 750 mμ wavelength on the recombinations in E. coli was studied. The strains of HfrC and AB1157 were used as the initial examples; selective recombinants were separated according to the milk sugar locus. The results of the experiments revealed interactions between TR and x-ray irradiations and tabulated data showed a higher survival and yield of recombinants than was anticipated theoretically. (R.V.J.)

48761 INACTIVATION OF INFECTION AND INTOXICATION MICRO-ORGANISMS BY IRRADIATION IN SEAFOOD. Quinn, Dorothy J.; Anderson, A. W.; Dyer, J. F. (Oregon State Univ., Corvallis). pp 1-13 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Studies were made to determine the limits of tolerance to γ radiation for 16 cultures in both broth and sterilized crabmeat. The cultures include seven species of Salmonella, three species of Shigella, and one species each of Neisseria, Mycobacterium, Escherichia, Proteus, Streptococcus, and Staphylococcus. All the cultures showed a near linear death curve when irradiated in broth (Hartsell's). However, when the above cultures were irradiated in crabmeat, the Salmonella and Shigella exhibited in varying degrees a rapid non-linear decline in viability with respect to the radiation doses. This decline tended to become very gradual as the irradiation dose increased, showing a distinct tailing effect of small numbers of increasing doses at the end of the dose-survival curve. The most pronounced tailing off was shown by Staphylococcus aureus, an organism in which survival could be observed even after subjecting inoculated crabmeat to over 2.0 Megarad. It was also observed with several of the above named species (Salmonella) that if the inoculated crabmeat was diluted with water (from 1 to 10 fold) and then irradiated, the tailing effect gradually disappeared as the dilution was increased, suggesting some protective properties possessed by the crabmeat. More evidence indicates that shrimp meat is similar to crab. (auth)

48762 EFFECT OF IONIZING RADIATION ON CL. BOTULINUM SPORES. Masokhina-Porshnyakova, N. N.; Ladukhina, G. V. (All-Union Research Inst. for the Canning and Vegetable Drying Industry, Moscow). pp 27-35 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

In the investigations on the radioresistance of the spores of Clostridium botulinum type A cultures (isolated from a sample of fresh carrot) and type B cultures (isolated from canned pork) were used. Ten strains were used. The experiments were carried out in phosphate buffer solutions at different pH values and with foodstuffs (green peas, meat). Direct calculation of the colonies following incubation at 28°C in a casein-fungus-medium containing agar was made. The optimum period for storing the irradiated samples before adding them to the medium was 2 wks. In addition to cultures characterized by a radioresistance curve with a shoulder, cases were observed where the radioresistance curve was exponential from the start. In a large number of cases (65%) another type of curve was obtained (mainly in the case of relatively low spore concentration). The results obtained do not always correspond with current theories on the effect of radiation on the cell. The exponential part of the radioresistance curves was clearly manifest in cases where the irradiated spores were in a neutral buffer solution. The value of D for suspensions irradiated and then stored in a buffer at pH 3.63 dropped by approximately ½ in comparison with the value for spore suspensions irradiated in a buffer at pH 7.0 to 6.9 and 4.6 to 4.5. The radioresistance of the cultures in meat and in green peas was lower than in the neutral buffer. In almost all experiments, a tail was discerned on the curve. In the course of the experiments the effect of single and fractional irradiation in a Cl. botulinum culture suspended in a neutral buffer solution was determined and a linear relation between the D value and the duration of the intervals between irradiations was found. (auth)

48763 TOXIN PRODUCTION BY CLOSTRIDIUM BOTULINUM TYPE E IN FISH. Hobbs, G. (Torry Research Station, Aberdeen, Scotland). pp 37-44 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

The incidence of Clostridium botulinum in fishery products in Britain and the North Sea is very low. The rate of toxin production was determined in various types of packaged fish which were inoculated with 10^1 to 10^6 spores of Cl. botulinum type E per 100 g of fish, at temperatures from 5 to 20°C. Radiation pasteurization at 0.3 Mrad resulted in an extension of the storage life of the fish but had little effect on the rate of toxin production. In fish irradiated at this level it is possible for toxin to develop in about the same time as it becomes organoleptically unacceptable, in some cases before this stage. Whether toxin is produced before the fish becomes unacceptable or not depends on several factors, the most important being level of contamination and storage temperature. The results presented indicate that as the level of contamination and the storage temperature are decreased, the safety margin between fish becoming unacceptable before development of toxin increases. (auth)

48764 RADIOSENSITIVITY OF TYPE E BOTULINUS TOXIN AND ITS PROTECTION BY PROTEINS, NUCLEIC ACIDS, AND SOME RELATED SUBSTANCES. Miura, T.; Sakaguchi, S.; Sakaguchi, G.; Miyaki, K. (National Inst. of Health, Tokyo). pp 45-54 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Three preparations of different purities of type E botulinus toxin containing toxicity or potential toxicity of about 50,000 LD_{50} per ml were irradiated with cobalt-60 in 0.05M acetate or 0.2M phosphate buffer, pH 6.0. The D values were about 2.1 Mrad for the cell suspension, about 0.21 Mrad for the cell extract, and about 0.04 Mrad for the purified preparation. Tryptic activation did not change the radiosensitivity of the toxin except for the cell suspension. Serum albumin, casein, deoxyribonucleic acid, and ribonucleic acid protected the purified and activated toxin against radiation detoxification; sugars or ascorbic acid showed little or no protection. The same extent of protection was afforded by sulfur-containing, aromatic or some heterocyclic amino acids and also by purines. Pre-irradiation of amino acid solutions with 7.7 Mrad did not appreciably change the protecting effect on type E toxin, except for the irradiated lysine which was shown to be protective in some experiments. Some amino acid derivatives, methionine sulfoxide, aminoethyl mercaptan, and cadaverine, were shown to be protective to different extents. (auth)

48765 RADIATION RESISTANCE OF BOTULINAL TOXINS. Roberts, T. A. (Agricultural Research Council, Cambridge, Eng.). pp 55-6 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Relatively little work has been done on the radiation resistance of toxins of Clostridium botulinum, but it is evident that the toxins are very much more resistant to radiation than are the spores of the organism. At present it seems improbable that irradiation of foods with the doses generally envisaged would effect any marked reduction in the amount of preformed toxin present. (auth)

48766 X-RAY INACTIVATION OF FOOT-AND-MOUTH DISEASE VIRUS AND VESICULAR STOMATITIS VIRUS IN AQUEOUS MEDIA. Johnson, C. D. (Univ. of Reading, Eng.). pp 65-75 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Radiation induced modifications to the biological activities and morphology of viruses are very dependent upon the techniques used in irradiation. Inactivation of foot-and-mouth disease virus and vesicular stomatitis virus by the effects of x-irradiation in dilute aqueous solutions were studied and the post-irradiation effects and virus sensitization effects are described. Comparisons are made between x-radiation and hydrogen peroxide as virus inactivating agents. Survival curves resulting from these modes of inactivation give information on the reaction kinetics and on the function of the virus protein. Virus morphology, as detected in electron micrographs, is more readily changed by irradiation in solution (indirect effect) than by irradiation of the virus in the frozen state (direct effect). In each case the observed physical changes are related to loss of infectivity and the results are shown to be consistent with the inactivation processes previously inferred. (auth)

48767 GAMMA RADIATION FOR STERILIZING THE CARCASSES OF FOOT-AND-MOUTH DISEASE VIRUS INFECTED ANIMALS. Baldelli, B. (Istituto Zooprofilattico Sperimentale dell'Umbria e Delle Marche, Perugia, Italy). pp 77-86 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Experiments on sterilization by means of γ rays of the carcasses of animals experimentally infected with foot-and-mouth disease virus (FMDV) have been carried out. The presence and survival of FMDV in the carcasses and in the organs of infected slaughtered animals were studied. The results obtained are sufficient to underline the problem of the sterilization of carcasses of animals infected by FMDV. The experiments on the inactivation of the FMDV

by, γ irradiation in vitro showed the same radiation sensitivity of the three types, O, A and C, of FMDV in aqueous solutions and showed that the fraction of surviving virus is an exponential function of the γ dose. The results obtained confirm the remarkable resistance of viruses to the effect of radiation. As far as the dry virus is concerned special tests indicated the necessity of greater doses for inactivating the same virus in the dry as opposed to the liquid state. The possibility of utilizing gamma rays for the sterilization of carcasses of infected (or suspected of being infected) FMDV animals using some tissues of infected animals (pigs) (blood, bone marrow, vertebrae, lymph nodes) were studied. The results obtained show that the inactivation of FMDV types O, A and C in the carcasses of infected animals can be made by treatment with γ rays. (auth)

48768 EFFECTS OF ADDITIVES ON RADIATION-RESISTANCE OF CL. BOTULINUM IN MEAT. Anderson, A. W.; Corlett, D. A. Jr.; Krabbenhoft, K. L. (Oregon State Univ., Corvallis). pp 87-97 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Beef ground round inoculated with 1 million spores of Clostridium botulinum per gram and containing various additives was exposed to gamma radiation. Mild heat treatment applied after irradiation reduced the survival of Clostridium botulinum strain A-5 spores, in raw ground beef. Heat applied before or during irradiation appears to have no effect. Sodium chloride, calcium chloride, mustard oil (allyl isothiocyanate), nutmeg, sodium citrate, and Versene reduced the dose or irradiation required to inactivate Clostridium botulinum spores (strains A-5 and B-115) in raw ground beef. Spores were inactivated in samples (irradiated at 2.0, 2.5 and 3.0 Mrad) that contained sodium nitrate (1000 ppm) plus sodium chloride (2.5%). Similar results were obtained when sodium nitrite (200 ppm) was substituted for sodium nitrate, except that there was evidence of spore survival in 1 of 120 cans irradiated at 2.0 Mrad. Spore destruction was based upon the absence of spores and mouse-lethal toxin in meat sub-cultures made from cans incubated at 35°C for 120 days. Spores were not destroyed when exposed to 2.5 or 3.0 Mrad in the absence of sodium nitrate, sodium nitrite, or sodium chloride. Furthermore, the use of these chemicals individually or together with radiation was ineffective. The additives alone in the absence of radiation also did not cause spore destruction. Radiation levels of 2.0, 2.5, and 3.0 Mrad, when used with sodium chloride at 1.5 or 2.0% and sodium nitrate at 500 ppM or sodium nitrite at 100 ppM, were ineffective. (auth)

48769 COMBINATION TREATMENT OF SPORES OF CL. BOTULINUM WITH HEAT PLUS RADIATION. Grecz, N.; Upadhyay, J.; Tang, T. C.; Lin, C. A. (Illinois Inst. of Tech., Chicago). pp 99-113 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Radiation resistance of spores of Clostridium botulinum is affected by the temperature during irradiation. Very low radiation resistance was consistently observed at 0°C when samples were in the liquid state. Below 0°C, the resistance of spores increased because the solidly frozen medium presumably decreased the diffusion of free radicals. As temperature increased above 0°C, processes of radiation protection occurred. When spores were subjected to low levels of radiation (0.6 to 0.8 Mrad), the heat resistance of the surviving spores was very remarkedly decreased. Experiments were designed to study what kind of radiation damage, i.e., direct hit or indirect action, is responsible for the loss of heat resistance of spores. Indirect effects were reduced by freezing the medium and lowering the temperature during irradiation down to −196°C. Spores of Clostridium botulinum 33A in phosphate buffer were irradiated to 0.6, 0.8, and 1.0 Mrad at irradiation temperatures ranging from +25 to −196°C and subsequently heated at 99°C. Survival curves revealed that all spores irradiated at +25 and 0°C were highly sensitive to heat with D_{10} = 5.5 min (after 0.6 Mrad), D_{10} = 3.0 min (after 0.8 Mrad), and D_{10} = 2.3 min (after 1.0 Mrad). For non-irradiated controls D_{10} was 23 min. Pre-irradiation at −25 through −196°C resulted in a much smaller loss of heat resistance with D_{10} clustering around 17.4 min (after 0.6 Mrad), 13.5 min (after 0.8 Mrad), and 11.5 min (after 1.0 Mrad). Loss of heat resistance after pre-irradiation at +25 and 0°C was highly influenced by the liquid state of suspending medium whereas at −25 through −196°C it depended primarily on radiation dose. The mechanism of heat sensitization of spores seems to be related primarily to migrating active free radicals at +25 and 0°C and to random splitting of molecular bonds at −25 to −196°C. (auth)

48770 EFFECTS OF HEATING AND GAMMA RADIATION ON THE INHIBITION OF BACTERIAL SPORES BY CURING AGENTS. Roberts, T. A. (Agricultural Research Council, Cambridge, Eng.). pp 115-21 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Studies on the resistance of bacterial spores to inhibition by sodium chloride in the recovery medium showed that both heat and gamma radiation are capable of inflicting damage to the spores which manifests itself as a reduction in salt tolerance. Radiation is at least as effective as heat in causing this damage. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 48409,48751, 48759, 48761—48765, 48768, and 48770.

48771 (ORO-676) RADIATION PASTEURIZATION OF GULF SHELLFISH. I. Annual Report, January 1–December 31, 1969. II. Final Summary of the Total Program. Liuzzo, Joseph A. (Louisiana State Univ., Baton Rouge. Dept. of Food Science). Feb 1970. Contract AT(40-1)-2951. 46p. Dep. CFSTI.

Studies were conducted during 1969 to ascertain the bacteriological profile of domestic, frozen, shell-on, headless shrimp. This investigation was conducted to establish a basis upon which changes in bacterial picture due to irradiation could be evaluated. Two hundred pounds of frozen shrimp were procured commercially or caught and processed from sources along the Gulf Coast. They were tested for total plate counts (TPC), E. coli and total coliform counts (TC). Lowest counts were observed in the shrimp which were caught and processed by personnel of the L. S. U. Department of Food Science. Highest TPC's were obtained from shrimp procured commercially from plants on the west coast of Florida. Commercial shrimp from Grand Isle and New Orleans, Louisiana had the greatest frequency and highest numbers of TC. The only sample to display high E. coli (fecal coliforms) came from Galveston, Texas. Very little correlation could be drawn between samples having high TPC and those with high TC and FC. The high counts without subsequent quality deterioration observed in some samples indicate that low level irradiation can be used in reducing the initial bacterial load to such levels that any subsequent thawing which could occur during transportation and distribution would not increase the microbial count and result in a spoiled product. If the samples are irradiated soon after packaging, the bacteria will not have multiplied to such proportions to cause spoilage which accompanies their metabolism. (auth)

48772 (SC-RR-70-423) STUDY OF THE EFFECTIVENESS OF THERMORADIATION STERILIZATION. Reynolds, Marcel C.; Lindell, Kermit F.; Laible, Nancy (Sandia Labs., Albuquerque, N. Mex.). Jun 1970. 28p. Dep. CFSTI.

Temperatures required for thermal sterilization are known to degrade certain heat sensitive components, materials and products. Simultaneous application of lower temperatures and low levels of gamma radiation produces a synergistic effect which can sterilize with fewer damaging side effects. A means of determining the optimum balance between heat and gamma radiation is demonstrated. (auth)

48773 (STI/PUB-149) PRESERVATION OF FRUIT AND VEGETABLES BY RADIATION. Panel Proceedings Series. Proceedings of a Panel on Preservation of Fruit and Vegetables by Radiation, Especially in the Tropics, Held in Vienna, 1–5 August 1966. (International Atomic Energy Agency, Vienna (Austria)). 1968. 158p. (CONF-660842). IAEA $3.00.

Ten papers and two abstracts are presented. Separate abstracts were prepared for each of the ten papers. One of the two abstracts appeared previously in NSA as 21:43544 and 21:41527. The other abstract appeared previously in NSA as 20:37156. (P.B.M)

For abstracts of individual papers see: 48779—48788.

48774 STUDIES ON MATURATION CHANGES IN FRUITS INDUCED BY IONIZING RADIATION. PART 5. EFFECTS OF GAMMA RADIATION ON RESPIRATION AND ETHYLENE PRODUCTION OF TOMATOES. Kato, Katsuichi (Shizuoka Univ., Japan); Chachin, Kazuo. Nippon Shokuhin Kogyo Gakkaishi; 17: No. 3, 97-103(Mar 1970). (In Japanese).

Tomatoes of two strains, Kozu and Yozu, were irradiated with ^{60}Co γ rays at 250, 500, and 1000 Krad at the rate of 250 Krad/hr. The fruits were kept at 20°C during irradiation and storage. The pattern of climacteric rise in respiration showed that irradiation (250 Krad) would delay ripening about 2 days in comparison with unirradiated samples. The fruits irradiated at 1000 Krad did not exhibit the pattern of climacteric rise in respiration during storage and failed to ripen normally. The ethylene production of tomatoes increased immediately after irradiation. The rates of production in the 250 Krad and 500 Krad fruits increased to peak at 2 days after irradiation and declined slowly thereafter, while the initial increase at the dose of 1000 Krad was temporary and the fruits exhibited a much lower rate of ethylene production during storage. The pigmentation and ethylene production of the irradiated fruits (250 Krad, 500 Krad) were slightly accelerated with 100 ppM and 500 ppM ethylene treatment. The ethylene production by tissue slices of the unirradiated and 250 Krad-fruits was enhanced by the addition of H_2O_2, glycolate, oxalate, L-methionine, L-methionine + H_2O_2, and citrate + H_2O_2, but that by the tissue slices of the 1000 Krad-fruits was much lower. When the phosphate buffer extract from the fruits irradiated at 1000 Krad was added to the slices of the unirradiated and 250 Krad-fruits, the ethylene production increased. (auth) (Japan)

48775 DUTCH ARE FIRST WITH IRRADIATED MUSHROOMS. Krause, W. Grower; 74: 74(11 Jul 1970).

The Dutch are the first to market γ-irradiated mushrooms to the public. The effects of radiation on the shelf life and flavor of mushrooms and other foodstuffs are discussed. The licensing regulations are considered. (UK)

48776 COMMERCIAL FEASIBILITY OF IRRADIATING HADDOCK AND COD FILLETS. 2. TEMPERATURE PATTERNS DURING SHIPMENTS OF FRESH FILLETS BY TRUCK AND BY RAIL. Kaylor, John D.; Murphy, Edward J. (Bureau of Commercial Fisheries Tech. Lab., Gloucester, Mass.). Contract AT(49-1)-1889. Fish. Ind. Res.; 16: 147-54(1970).

For fresh haddock and cod fillets to be irradiated and shipped commercially to distant points in the United States, the fillets must be kept near the temperature of ice during distribution. To check on the temperatures to be expected the principal methods of commercial distribution of fresh fishery products were surveyed. Present commercial methods of distributing fresh haddock fillets result in fillet temperatures that average less than 40°F, a temperature that would be sufficiently low to permit shipment of irradiated fillets to the most distant parts of the country. (auth)

48777 EFFECT OF GAMMA ENERGY ON SALMONELLAE AND ITS APPLICATION TO POULTRY FEEDS. Epps, Norman Arthur. Montreal; McGill Univ. (1969).

Thesis.

Growth-irradiation cycling of several Salmonella serotypes in broth culture media resulted in increased resistance to γ energy when compared with parent strains. The radiation-resistant strains also exhibited alterations in morphology and biochemical reactions, although in most cases cultures were still identifiable as Salmonellae. Aberrant morphological-radioresistant mutants of selected serotypes were less pathogenic for day-old chicks than were parent types. Differences in the yield, chemical composition and S value were found with endotoxin extracted from parent and resistant S. typhimurium cultures. All parent cultures and only one radiation-resistant culture were lysed by the 0-1 genus specific phage. A dose of 0.1 Mrad was specified for treatment of poultry feed for the control of Salmonellae. Vitamin A content was not adversely affected by the above treatment. (Diss. Abstr.)

48778 RADIATION PRESERVATION OF FISH. II. TROUT. Ehlermann, D.; Muenzner, R. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Lebensm.-Untersuch. Forsch.; 142: 7-17(Feb 1970). (In German).

Whole rainbow trout (Trutta iridea W. Gibb.) from a nearby farm were gutted, immediately packed in plastic films impermeable to oxygen and water vapor, irradiated with 10 MeV electrons, and stored under wet ice. Samples were examined for organoleptical, chemical and microbiological quality during five weeks. Shelf life of unirradiated controls was 15 days, a dose of 50 krad prolonged shelf life to 21 days. Doses of 100 and 200 krad caused a certain loss of the typical fine flavor of trout, without substantial further improvement of shelf life. A dose of 400 krad prevented spoilage for over 5 weeks but affected flavor markedly. In comparison with other fish species, trout is particularly sensitive to irradiation. The chances for practical application of the radiation process therefore appear less favorable in this case. (auth)

48779 EFFECT OF RADIATION ON THE RIPENING OF BANANAS AND AVOCADO PEARS. Kahan, R. S. (Soreq Nuclear Research Centre, Yavne, Israel); Nadel-Shifman, M.; Temkin-Gorodeiski, N.; Eisenberg, E.; Zauberman, G.; Aharoni, Y. pp 3-11 of Preservation of Fruit and Vegetables by Radiation. Vienna; International Atomic Energy Agency (1968).

From Panel on Preservation of Fruit and Vegetables by Radiation, Vienna, Austria. See STI/PUB-149; CONF-660842.

Israel dwarf Cavendish variety bananas were irradiated 1 to 7 days after picking with doses in the 10 to 80 krad range and stored at 17°C. All treatments caused darkening of patches of the skin but did not affect the appearance or taste of the edible portion. Damage increased with dose and 60 to 80 krad sometimes caused splitting of the skin. Relative delays in ripening were not reproducible between experiments. In one experiment doses up to 40 krad delayed ripening, while 60 to 80 krad sometimes accelerated it. The position of the hand on the stalk seemed to be important, but the results were complex. Delays were shorter for fruit picked late in the harvest season. Respiration rate measurements at 16°C showed maximum delays of 8 to 16 days in the onset of the climacteric. Four avocado varieties were treated with doses up to 100 krad. There were marked varietal differences, the earliest variety, Ethinger, giving the longest delays in ripening whereas the main variety, Fuerte, was less affected. The ripening of the late variety, Hass, was accelerated by irradiation. For Ethinger, irradiation was most effective for fruit picked early in the harvest season. Doses of above 20 krad caused some damage, either as darkening of the skin or the edible portion. (auth)

48780 FOOD IRRADIATION PROGRAMME IN VENEZUELA. Solanas, J.; Darder, A. (Instituto Venezolano de Investigaciones Cientificas, Caracas). pp 13-27 of Preservation of Fruit and Vegetables by Radiation. Vienna; International Atomic Energy Agency (1968).

From Panel on Preservation of Fruit and Vegetables by Radiation, Vienna, Austria. See STI/PUB-149; CONF-660842.

A pilot experiment was carried out to study the feasibility of preserving various foodstuffs by irradiation. The products selected for these tests were potatoes, onions, and strawberries. A 500-Ci ^{60}Co source was used, and various doses were administered. The irradiated potatoes and onions were stored in an aerated place under normal conditions, at 10 to 22°C and 60 to 95% humidity. Sprouting was inhibited in potatoes by doses of 10 krad and above, and weight losses after eight months of storage amounted to about 7%. In onions sprouting was inhibited by a dose of 3 krad, and weight losses after 8 mos. of storage amounted to 15%. Strawberries could be maintained in good condition for a period of 25 days when irradiated with 200 krad and stored at a temperature of 3°C. The ripening period of bananas was extended to 25 days by a dose of 30 krad, as compared with 12 days in the unirradiated controls. Of a group of mangoes irradiated with 100 krad, about 75% were in normal condition after 15 days and 50% after 20 days (storage at 18°C and 80% humidity). Weight losses were extremely small and there were no variations in flavor, odor or texture. No conclusive results were obtained with pineapples irradiated at doses between 10 and 40 krad. (auth)

48781 STORAGE TESTS AND SPROUTING CONTROL ON UP-TO-DATE VARIETY POTATOES AND ON AN EXPERIMENTAL ONION VARIETY (BEIT ALPHA). Kahan, R. S. (Soreq Nuclear Research Centre, Yavne, Israel); Temkin-Gorodeiski, N. pp 29-37 of Preservation of Fruit and Vegetables by Radiation. Vienna; International Atomic Energy Agency (1968).

From Panel on Preservation of Fruit and Vegetables by Radiation, Vienna, Austria. See STI/PUB-149; CONF-660842.

Problems of growing and storing potato and onion crops in Israel are discussed. Summer crop potatoes were removed from 8°C storage towards the end of their dormancy, and treated at about 25°C with 6 to 14 krad doses and then returned to storage for up to 12 months at 4, 8, and 14°C and ambient temperature. At each inspection date the potatoes were tested for sprouting, rot incidence, and loss in weight; these measurements were repeated after 2 and 4 wks shelf-life at ambient conditions. Six krad gave incomplete control after storage for 10 wks after irradiation. Ten krad and 14 krad prevented sprouting at all test dates. Under some conditions irradiated tubers showed higher rot incidence. Dose rates effects, comparing treatments at 19 and 76 krad/h, were complex. Irradiation was at 2 dates, 20 and 40 days after harvesting, using doses of 6, 10, and 14 krad. A preliminary experiment on sprout control is in progress on a locally developed onion variety (Beit Alpha) that, in contrast to other locally grown onions, matures in the winter. Crops harvested in two regions, in December and January respectively, were each treated with 2, 7, or 12 krad, at three post-harvest dates (1 to 40 days). Storage was at 0°C and ambient temperature. There was little external sprouting in the non-irradiated controls until April, and none in the irradiated bulbs. Irradiation markedly reduced internal sprouts. Accelerated growth tests showed that all doses pre-

vented external sprouting, but gave different degrees of inhibition on internal sprouting. (auth)

48782 CHANGES IN SOME CHEMICAL CONSTITUENTS IN IRRADIATED FRUITS AND VEGETABLES. Maxie, E. C.; Sommer, N. F. (Univ. of California, Davis). Contracts UCD-34P80; UCD-34P73. pp 39-56 of Preservation of Fruit and Vegetables by Radiation. Vienna; International Atomic Energy Agency (1968).

From Panel on Preservation of Fruit and Vegetables by Radiation, Vienna, Austria. See STI/PUB-149; CONF-660842.

The major chemical changes induced by ionizing radiations in fresh fruits and vegetables are reviewed. The importance of physiological state of the commodities as it may affect both physiological response and chemical changes induced by irradiation is discussed. Considering the current literature, it is concluded that textural changes resulting from radiation-induced breakage of the macromolecules of pectin, cellulose, hemicellulose, and perhaps starch are the most limiting phenomena in attempts to use irradiation as a means of extending the storage and shelf life of fresh fruits and vegetables. It is concluded that losses in vitamins, changes in appearance, aroma, flavor, and general quality are not limiting at irradiation doses the fruit's structural components can tolerate. (auth)

48783 INFLUENCE OF IONIZING RADIATION ON FLAVONOID PIGMENTS OF SOME BERRY FRUITS. Horubala, A. (Warsaw Agricultural Univ.). pp 57-63 of Preservation of Fruit and Vegetables by Radiation. Vienna; International Atomic Energy Agency (1968).

From Panel on Preservation of Fruit and Vegetables by Radiation, Vienna, Austria. See STI/PUB-149; CONF-660842.

The following problems are presented: The rate of destruction and regeneration of anthocyanin pigments in some berry fruits, pulps, and juices. Color changes in these irradiated environments. The use of some protective agents (N_2, CO_2, SO_2, ascorbic acid) for anthocyanin pigments during irradiation. The influence of radiation on the anthocyanidins, flavonols, leucoanthocyanins, and catechins in berry juices. (auth)

48784 EFFECTS OF IONIZING RADIATION ON THE STORAGE PROPERTIES OF FRUITS. Clarke, I. D. (Wantage Research Lab., Eng.). pp 65-92 of Preservation of Fruit and Vegetables by Radiation. Vienna; International Atomic Energy Agency (1968).

From Panel on Preservation of Fruit and Vegetables by Radiation, Vienna, Austria. See STI/PUB-149; CONF-660842.

It was possible to correlate the immediate softening effect of radiation on three different types of fruits with changes in the solubility of the pectic substances. The decrease in texture, which occurred in all fruits during storage, could be correlated with the expected increase in the most soluble pectin fraction. No significant dose effects in the pectic substances were observed after prolonged storage, even in pears where the irradiated fruits were firmer than the untreated fruits at the end of the storage period. Physiological changes undoubtedly occurred in irradiated fruits, which, in the case of internal breakdown, may not be detected until after a prolonged storage period. Other changes, such as the accelerated loss of malic acid in apples, may become apparent within a relatively short storage period. A dose of 2×10^5 rad gave very good control of Gloeosporium species attack on stored apples, but the advantage of the treatment could be nullified by control of the fungus in the orchard. The storage life of irradiated apples could be severely curtailed by the incidence of physiological breakdown. Many experiments indicated that the ripening process of pears could be delayed by radiation and the flavor always developed fully if the pears were stored at ambient temperatures, even after doses exceeding 2×10^5 rad. However, the flavor never developed in either the irradiated pears or apples when stored at low temperature under the conditions at Wantage. Though some of the aspects examined in this paper would suggest an accelerated rate of ripening in irradiated apples, it was never possible to be certain. (auth)

48785 EFFECT OF GAMMA RADIATION ON APPEARANCE, COMPOSITION, AND ENZYMATIC ACTIVITIES OF CITRUS FRUITS. Monselise, S. P.; Kahan, R. S. (Hebrew Univ., Rehovoth, Israel. Soreq Nuclear Research Centre, Yavne, Israel). pp 93-104 of Preservation of Fruit and Vegetables by Radiation. Vienna; International Atomic Energy Agency (1968).

From Panel on Preservation of Fruit and Vegetables by Radiation, Vienna, Austria. See STI/PUB-149; CONF-660842.

As an introduction the main components as well as the growth and development of citrus fruits are reviewed briefly. Shamouti oranges were irradiated at early and full maturity on two successive seasons with doses ranging between 14 and 280 krad. Only the data collected on fully mature oranges are presented. Internal quality of oranges was very little affected, but peel was considerably affected in appearance (mild to severe pitting according to dose) and in composition. Ascorbic acid and reducing sugars in the external peel layers and their catalase activity decreased while their peroxidase activity increased with increasing doses. Some differences were found in the reaction of tissues, between orchards in the same year and between years in the same orchard, but on the whole, results found in different occasions compare well, notwithstanding season, location, rootstock, and the different dose rate, and irradiation equipment used in successive years. Preliminary work was carried out on Valencia oranges to test possible effects of different dose rates. Doses ranged between 52 and 208 krad and rates between 52 and 312 krad/h. While damage to peel about two weeks after irradiation was much lower than for Shamouti oranges at comparable doses and rates, peroxidase activity of external peel layers was very much affected. The effect of different rates of irradiation was not of paramount importance except in the case of peroxidase activity. Dose-rate effects should be further studied. Irradiated grapefruits were tested at progressively longer intervals from the day of irradiation. Irradiation doses ranged between 30 and 240 krad at 190 krad/h. External damage to peel, already evident after 8 days, attained values after 21 days as high as for Shamouti oranges, i.e., more than 50% at doses above 60 krad. Here again internal quality was only little affected while peel components and enzymatic activities were clearly affected. It is interesting that catalase activity in irradiated grapefruits increased with increasing doses of irradiation. (auth)

48786 TISSUE TEXTURE AND INTERMEDIARY METABOLISM OF IRRADIATED FRESH FRUITS AND VEGETABLES. Massey, L. M. Jr. (Cornell Univ., Geneva, N. Y.). pp 105-23 of Preservation of Fruit and Vegetables by Radiation. Vienna; International Atomic Energy Agency (1968).

From Panel on Preservation of Fruit and Vegetables by Radiation, Vienna, Austria. See STI/PUB-149; CONF-660842.

Radiation-induced changes in the texture of plant tissues were studied. Data are presented indicating that the initial effect of radiation on tissue texture is that of destruction of the semipermeable characteristics of the cell to water. This is followed, at somewhat higher doses, by softening as a result of structural polysaccharide degradation. Pectin degradation has been studied in detail, and significant findings pertaining to the mechanism of these changes are discussed. A summary of studies on the effect of radiation upon the metabolism of fresh tissues is presented. In carrot tissues it has been found that, although radiation exerts a relatively minor effect upon the metabolism of glucose and pyruvate, it does accelerate the utilization of most tricarboxylic acid cycle intermediates with the exception of succinate. It is believed that this acceleration accounts for the frequently reported radiation stimulation of carbon dioxide evolution. The presence of a radiation-resistant metabolic shunt circumventing the radiation-sensitive succinate dehydrogenase system (such as the glyoxylate bypass) is postulated. Data are also presented indicating that radiation degradation products of sucrose do not contribute to radiation-induced abnormality in either carbohydrate or tricarboxylic acid catabolism in mature carrot tissues. (auth)

48787 ROLE OF CALCIUM IN SOFTENING AND REFIRMING IRRADIATED PLANT TISSUES. Al-Jasim, H.; Makarkis, P.; Nicholas, R. C. (Michigan State Univ., East Lansing). pp 125-7 of Preservation of Fruit and Vegetables by Radiation. Vienna; International Atomic Energy Agency (1968).

From Panel on Preservation of Fruit and Vegetables by Radiation, Vienna, Austria. See STI/PUB-149; CONF-660842.

Softening of fruits and vegetables upon exposure to ionizing radiations has been repeatedly reported. In the experiments reported here it is shown that pasteurizing doses of radiation result in calcium release from plant tissues and radiation-induced softening can be minimized by dipping small fruits in a $CaCl_2$ solution. Tomato leaves and strawberries containing ^{45}Ca were extracted with 70% ethanol to remove soluble Ca forms and subsequently exposed to gamma rays and 1-MeV electrons in the dose range of 0 to 595 krad. Upon rewashing with 70% ethanol, 3 to 7 times as much radiocalcium was found in the extract of the irradiated samples than the control samples. A water suspension of ^{45}Ca pectate also contained more soluble ^{45}Ca after than before irradiation. Sweet cherries dipped in a $CaCl_2$ solution before or after irradiation were firmer than irradiated cherries which were not treated with $CaCl_2$. (auth)

48788 RESPIRATION PATTERNS OF IRRADIATED TOMATOES. van Kooy, J. G. (EURATOM-ITAL, Wageningen, Netherlands). pp 129-41 of Preservation of Fruit and Vegetables by Radiation. Vienna; International Atomic Energy Agency (1968).

From Panel on Preservation of Fruit and Vegetables by Radiation, Vienna, Austria. See STI/PUB-149; CONF-660842.

Tomatoes have a well-defined climacteric that facilitates the determination of the stage of maturity. Other features advantageous to physiological research are their year-round availability, size, and storage stability. The carbon dioxide exchange of whole fruit has been studied in relation to total irradiation dose and stage of maturity. Methods used for the analysis of CO_2 and results obtained are presented. (auth)

48789 SALMONELLA RADICIDATION OF DRY MIXED FEEDS AND FEED INGREDIENTS. Mossel, D. A. A. (Central Inst. for Nutrition and Food Research TNO, Zeist, Netherlands. San Marcos Univ., Lima). pp 15-25 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Feed components contaminated with Salmonellae act as vehicles in the transmission of these bacteria to slaughter animals and hence to meat and poultry. Terminal decontamination of ingredients or mixed feed seems required because sanitary improvements in processing, bagging, and storage do not always appear effective in considerably reducing Salmonella contamination rates. Experiments were carried out to assay the decontamination effect of pelletization of mixed feed. Enumeration of Enterobacteriaceae was used as the analytical criterion. It appeared that a temperature over 80°C generally led to five decimal reductions in enterobacteriaceae counts; however, also currently used lower temperatures may bring about two decimal reductions only. Following earlier experiments with fish meal, range finding tests on the decontamination of mixed feed with ^{60}Co γ rays were also performed. To achieve five decimal reductions in the counts of the most resistant Enterobacteriaceae that were encountered about 0.5 Mrad was required; survival curves were generally not linear, so that overall effective dose had to be used as a parameter. Feeding experiments with rats, using 35% fish meal irradiated at 0.8 Mrad in the diet for 2 yr, demonstrated that neither losses of nutritive value nor the occurrence of orally toxic factors is effected by such an irradiation treatment. It is recommended that pilot plant tests be carried out. In these tests an attempt should be made to combine improved sanitation and pelletizing with a terminal radiation treatment of the bagged material with the lowest dose required. Such tests should preferably be carried out in suitable areas of countries like Peru or Chile. A brief outline is given of the development work and training of scientific and technical staff that should be carried out during the installation of such a pilot plant. (auth)

48790 REDUCTION OF RADIATION DOSE REQUIREMENTS OF FOODS BY ADDITIVES. Farkas, J.; Kiss, I.; Andrassy, E. (Central Food Research Inst., Budapest). pp 123-31 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Utilizing a recording photometer, a rapid turbidimetric method was worked out for the determination of nisin and tylosin activity. Those antibiotics affected by irradiation with x rays in the range of 0 to 800 krad were also investigated. In a solution of pH 5.7 containing pea extract, the activity of the antibiotics decreased at a high rate when irradiated up to 200 krad, however, this rate slowed down with further radiation treatment. Tylosin lactate proved more radiation resistant than nisin. When treated with dosages between 400 and 800 krad the activity of nisin decreased by 73 to 87% and that of tylosin lactate by only 52 to 57%. During a 1 mo storage at room temperature the residual activity of both the irradiated and untreated antibiotic solutions remained practically unchanged. The addition of antibiotics increased the preserving effect of x-rays. A 1:1 mixture of peas and a solution containing 4% sugar and 1.5% salt was heat treated for 15 min at 70°C. Samples taken from the liquid phase of this mixture were treated with various radiation-antibiotic combinations. When 100 ppM nisaplin or 1 ppM tylosin lactate was added the radiation dose requirement was a quarter of that needed in the control samples to ensure microbiological stability. (auth)

48791 EFFECT OF IONIZING RADIATION AND ANTI-OXIDANT TREATMENT ON THE QUALITY AND STORAGE LIFE OF VACUUM-PACKED TROUT AT 0°C. Hansen, P. (Ministry of Fisheries, Copenhagen); Joergensen, B. V. pp 133-8 of Microbiological Problems in Food Preservation by Irradiation. Vienna; International Atomic Energy Agency (1967).

From Panel on Microbiological Problems in Food Preservation by Irradiation, Vienna, Austria. See STI/PUB-168; CONF-660674.

Ice packing provides a simple and economical means of maintaining the storage temperature of fresh fish at 0°C. Vacuum packing is valuable in suppressing oxidative rancidity during iced storage of fatty fish. During prolonged storage at 0°C of vacuum packed gutted trout no growth of sulphite-reducing Clostridia is noted, but the total viable aerobic count may rise to several millions per gram in the third week of storage. Non-irradiated trout have a maximum storage life of 2 – 2½ weeks. Radiation of vacuum packed trout increased the bacterial lag phase. At a dose of 100 krad a total viable count of 1 million per gram was reached at the end of the fourth week of storage. A short dip in an aqueous solution of ascorbic acid will reduce harmful effects of irradiation on the eating quality of the trout. Trout dipped in an 0.2% ascorbic acid solution before vacuum packing could be treated to doses from 50 to 200 krad without immediate effects upon the eating quality. The quality, however, decreased steadily independent of dose during 4 weeks of iced storage, and first class quality was retained for about 3 weeks only, although the fish remained edible for more than 4 weeks. The loss of quality occurred more rapidly when trout were irradiated without prior ascorbic acid treatment. (auth)

48792 EFFECTS OF RADIATION PASTEURIZATION ON SALMONELLA. I. PARAMETERS AFFECTING SURVIVAL AND RECOVERY FROM CHICKEN. Previte, J. J.; Chang, Y.; El-Bisi, H. M. (U. S. Army Natick Labs., Mass.). Can. J. Microbiol.; 16: 465-72(Jun 1970).

Growth of Salmonella typhimurium, strain RIA, in minimal broth supplemented with methionine, produced a population of cells that was more sensitive to ^{60}Co irradiation than were those grown in brain heart-infusion. The resistance values (D) were 0.056 and 0.066 Mrad, respectively. D was not significantly different when the bacteria were irradiated at 4°C on fresh or frozen-thawed germ-free chicken, or on conventional chicken sterilized by autoclaving, or by exposure to 2 Mrad of ionizing radiation. It was generally higher when the cells were irradiated in the original growth medium than on chicken. D of five different strains of S. typhimurium irradiated at 4°C on autoclaved chicken varied from 0.052 to 0.068 Mrad. The greatest increase in resistance was produced by decreasing the temperature during irradiation. S. typhimurium, RIA, attained a D value of 0.293 Mrad at –80°C. The effect of the recovery media on survival is equivocal. In some instances nutrient and minimal agar seemed to provide slightly better recovery of strains SR-11 and RIA. Enrichment of complex media with yeast extract did not increase recovery. The results indicate that of those parameters studied, the most significant effects on resistance were due to the temperature during irradiation. (auth) (Canada)

48793 VITAMINS IN THE EGG DURING ITS PRESERVATION. Calet, C.; Blum, J. C. (Institut National de Recherches Agronomiques, Nouzilly, France). Ann. Nutr. Aliment.; B24: 201-26 (1970). (In French).

The egg is an excellent source of vitamins for man; it possesses all the liposoluble and hydrosoluble factors except vitamin C, and has even been shown to contain undetermined growth factors. Eggs in the shell are often consumed several weeks or months after they are gathered and it is therefore important to know the effect of preservation methods on the vitamins during storage. Several methods may be used, in particular gamma irradiation. This treatment affects the protein structure but without modifying the lipids. Irradiation causes no damage to the B vitamins except in the case of vitamin B_1, much of which is lost. Nevertheless whatever the method used for eggs in the shell the vitamins are on the whole very stable. On the other hand in shell-less eggs, which consequently suffer the loss of various means of protection, the vitamins are likely to be damaged. (auth) (France)

48794 VITAMINS IN MEAT AND OFFAL: CHANGES BROUGHT ABOUT BY THEIR PROCESSING. Rozier, J. (Ecole Nationale Veterinaire d'Alfort, Maison-Alfort, France); Rosset, R. Ann. Nutr. Aliment.; B24: 247-85(1970). (In French).

Meat and offal for human consumption are considered to be good sources of vitamins. Meat is rich in the B group and offal in liposoluble and hydrosoluble vitamins. Since these foods are seldom eaten raw it is necessary, in order to estimate the contribution of the vitamins to the diet, to know the changes they undergo during the various transformation and conservation processes used on meat and offal. The main treatments involve cold, heat, addition of vitamin derivatives or similar substances, dehydration and ionizing radiations. Conservation by ionizing radiations is still at the experimental stage and usually its disadvantages are not offset by its advantages. The resistance of the vitamins to ionizing radiations is fairly high, but varies according to the vitamin and certain other factors: thus vitamin B_1 is found to be the least stable. (auth) (France)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 48029, 48078, and 48208.

48795 (CONF-690954) TECHNICAL PAPERS OF THE 23rd METALLOGRAPHIC GROUP MEETING HELD SEPTEMBER 11–12, 1969, SAN FRANCISCO, CALIFORNIA. Gray, R. J. (comp.) (Oak Ridge National Lab., Tenn.). 243p. Dep. CFSTI.

This compilation of papers consists of ten papers presented at the conference and four abstracts of papers. A separate abstract was prepared for each of the ten papers. (J.R.D.)

For abstracts of individual papers see: 48205, 48803, 48804, 48814–48816, 48848, 48860, 48871, and 48885.

48796 (LMEC-70-13) LIQUID METAL ENGINEERING CENTER (LMEC) SEMIANNUAL TECHNICAL PROGRESS REPORT, JANUARY–JUNE 1970. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 10 Sep 1970. Contract AT(04-3)-700. 201p. Dep. CFSTI.

Wastage data for 2¼ Cr–1 Mo ferritic steel obtained in APDA Rig 10 tests have been analyzed. The correlations obtained so far are less than satisfactory, but do offer promise that the approach being employed is likely to be fruitful. The computer simulation of a flashing-water jet has been extended from the one-dimensional model to a two-dimensional planar-jet model. This permits the calculation of jet parameters in terms of axial distance from the choke plane. Alco/BLH steam generator boiling phenomena tests were continued until development of additional tube leaks. Test results confirmed the poor thermal performance characteristics previously established, and revealed a performance instability in various operating modes. A roller-nut type control rod drive mechanism (CRDM) has been operated in a sodium vapor/argon gas environment while suspended 10 ft above a sodium pool at temperatures of 600, 800, and 1050°F. To date, the CRDM has performed the withdrawal, insertion, and scram functions satisfactorily. Data obtained from screening tests of a large number of candidate materials in static and unidirectional sliding contact with sodium vapor or liquid were analyzed and summarized. The diagnostic test program on the steam generator and intermediate heat exchanger has been performed. Preliminary evaluation of test data indicates large variations in levels of heat transfer performance. An evaluation was performed to determine an improved stabilization procedure for the Microdot SG420 strain gages. Significant changes in the apparent strain characteristics of the gage were noted during thermal soak tests at 900°F after 500 and 860 hr. Three gages were tested after stabilizing at 1200°F for 48 hr. Test results after a 500- and 1000-hr soak at 900°F indicated an improvement in gage stability. Results of oxygen-in-sodium analyses, showing the degree of radial segregation occurring in ½-in.-dia sodium sample tubes, indicated that the major amount of oxygen is concentrated in that small amount of sodium adjacent to the inside-diameter tube surface. A preliminary metallurgical examination of the cracks in the Alco steam generator lower tube sheet was performed. Based on observations, it is postulated that stress corrosion was the most likely cause of failure. FFTF Test T–1B was completed after 2982.3 hr of testing at steady-state conditions of 750°F sodium temperature and a test section ΔP of 140 psi. Post-test examination of the T-1-5 module revealed the presence of particulate matter and an investigation was conducted to determine the nature and extent of the particulate contamination in the LCTL sodium. Followup inspection of the 3-in. loop corrosion revealed no significant degradation as compared with results of previous examinations. (J.R.D.)

48797 ADVANCES IN MATERIALS RESEARCH. VOLUME 4. Herman, Herbert (ed.). New York; John Wiley and Sons, Inc. (1970). 500p.

Five articles on diverse branches of materials science are presented. A separate abstract was prepared for one article. Articles for which no abstracts were prepared are concerned with precipitation in crystalline ceramics, diffusion in multicomponent systems, effects of grain size on mechanical properties, and thermodynamics of phase diagrams. (J.R.D.)

For an abstract of one chapter see: 48798.

48798 ROLE OF COMPUTER EXPERIMENTS IN MATERIALS RESEARCH. Beeler, J. R. Jr. (Battelle-Northwest, Richland, Wash. General Electric Co., Cincinnati. North Carolina State Univ., Raleigh). Advan. Mater. Res.; 4: 295–476 (1970).

A group of computer experiments are described which exemplify the use of such experiments in materials research. The types of experiments discussed include dynamical method calculations, variational method calculations, Monte Carlo method calculations, and pattern development calculations. A highly developed computer experiment system is usually a blend of these types. (J.R.D.)

Corrosion and Erosion

Refer also to abstract 49971.

48799 MASS SPECTROMETRIC STUDIES OF NITROGEN EVOLUTION FROM PRENITRIDED ZIRCONIUM DROPLETS BURNED IN PURE OXYGEN. Meyer, R. T.; Breiland, W. G. (Sandia Labs., Albuquerque, N. Mex.). High Temp. Sci.; 2: 286–8(Sep 1970).

Results of experiments in which solid Zr was prenitrided with $^{15}N_2(g)$ and then burned in pure $O_2(g)$ are reported. This work was done to test the equivalence of the chemical reactions leading to microbubble formation and droplet explosion for prenitrided Zr burned in pure O_2 and for pure Zr burned in N_2/O_2 mixtures, and to prove that the origin of $N_2(g)$ in intact microbubbles is nitrogen evolved within the liquid droplet at high temperature rather than nitrogen which diffused inward from the ambient atmosphere after bubble formation. The results on the detection of $^{15}N_2(g)$ within droplets and microbubbles show that the source of $N_2(g)$ is its release in the high temperature combustion phenomenon. Furthermore, both the observed transition from dense droplets through bubbles and holes to complete explosions with increasing degree of prenitridation and the absolute amounts of $^{15}N_2(g)$ detected firmly indicate the equivalence of the reaction mechanism for Zr burned in N_2/O_2 and for prenitrided Zr burned in pure O_2. (J.R.D.)

48800 BEHAVIOUR OF ZIRCONIUM ALLOYS IN TERPHENYLS AT HIGH TEMPERATURE. Imarisio, G.; Ronsecco, C. (CCR–EURATOM, Ispra, Italy). Energ. Nucl. (Milan); 17: 489–97(Aug 1970). (In Italian).

Zirconium alloys can be used in terphenyl at high temperatures, provided that water and organic chlorine are kept within definite limits. In this case corrosion is similar to that occurring in steam at the same temperature and partial pressure. The already known alloys, however, show an excessive corrosion rate at the high temperature associated with the use of polyphenyls as coolant in nuclear reactors. Therefore some zirconium alloys suitable for such environment were developed. They are: Zr–1% Cu–0.4% Fe;—Zr–1.4% Cu–0.4% Fe; and Zr–0.8% Fe–0.8% V;—(% in weight). The oxidation and hydriding rates of such alloys between 380 and 420°C were found to be acceptable for their application in organic cooled reactors. (auth)

48801 CORROSION TEST ON CONDENSER TUBES BY A MODEL CONDENSER AT NYU BAY IN MIHAMA. CORROSION RESISTANCE OF SOME CONDENSER TUBES AND THE EFFECT OF IRON ION AND SOLID DEPOSITS. Sato, Shiro; Sagisaka, Kiyoji (Sumitomo Light Metal Industries Ltd., Tokyo). Sumitomo Keikinzoku Giho; 11: No. 2, 1–19(Apr 1970). (In Japanese).

Condenser tubes of an atomic power plant were corrosion tested using a model condenser containing three tube bundles with tubes of Albrac (modified aluminum brass), special aluminum brass, 90–10 cupronickel, 70–30 cupronickel and titanium of commercial purity. Seawater with and without the addition of ferrous sulphate passed through the tubes, in some of which the solid deposits were artificially inserted. For the general corrosion resistance, the inspection of the removed tubes revealed that the titanium tubes showed the best resistance to corrosion, aluminum brass tubes showed fairly good corrosion resistance in comparison with 90–10 and 70–30 cupronickel tubes, 90–10 cupronickel tubes had the least resistance to corrosion. It was observed that the solid deposits caused variations in the local corrosion in the copper alloy tubes but not in titanium tubes. The copper alloy tubes with clean surfaces seemed more sensitive to this type of corrosion than those with surfaces covered with films. It was shown that for aluminum brass tubes, the injection of ferrous sulphate was effective in suppressing both the general corrosion and the local attack by solid deposits. (auth) (Japan)

48802 OBSERVING SURFACE OXIDATION OF MOLYBDENUM WITH THE STATICAL METHOD OF SECONDARY ION MASS SPECTROSCOPY. Benninghoven, A. (Univ., Cologne). Chem. Phys. Lett.; 6: 626–8(15 Sep 1970).

The statical method of secondary ion mass spectroscopy is

shown to be a powerful tool for the analysis of chemical reactions at the surface of solids. This method is demonstrated using as an example the initial surface oxidation of molybdenum. (auth)

Preparation and Fabrication

Refer also to abstract 49090.

48803 (CONF-690954-, pp 161-71) ELECTROLYTIC POLISHING OF HOMOGENIZED DELTA PHASE PLUTONIUM. Rencken, D. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Technical papers of the 23rd metallographic group meeting held September 11-12, 1969, San Francisco, California.

A new technique was developed for electrolytically polishing homogenized delta phase plutonium. Homogenized delta plutonium, which is soft (38 dph), is very difficult to mechanical polish without either scratches or flow metal. Mechanical polishing of delta plutonium is especially difficult because it is performed in a glovebox, but this technique utilizing a newly developed optical electro polisher-etcher, removes all flow metal and scratches. Specimens were satisfactorily electrolytically polished at 12.0 A/cm^2 for 5 to 15 seconds using an electrolyte of 10% nitric acid, and 90% ethylene glycol. Photomicrographs showing the removal of flow metal and scratches are included. (auth)

48804 (CONF-690954-, pp 220-43) METALLOGRAPHIC EVALUATION OF EXPLOSIVELY BONDED AND EXPLOSIVELY COMPACTED MATERIALS. McGrath, F. E. (Battelle Memorial Inst., Columbus, Ohio.).

From Technical papers of the 23rd metallographic group meeting held September 11-12, 1969, San Francisco, California.

Explosive bonding and explosive compacting processes have been used with success to join similar and dissimilar metals classified as incompatible when fusion or diffusion joining methods are used and to fabricate metal matrix composites. Some of the advantages and disadvantages of the two explosive processes are described along with some of the specific techniques used at Battelle-Columbus Laboratories. Metallographic methods for evaluating the techniques are discussed and demonstrated by photomicrographs of numerous materials that have been explosively bonded and compacted. (auth)

48805 (NP-18456) EQUIPMENT FOR ZONE MELTING InSb FILMS USING A HOT WIRE. Report 6420. Williamson, W. J. (Postmaster-General's Dept., Melbourne (Australia). Research Labs.). Sep 1969. 15p. Dep. CFSTI (U. S. Sales Only).

Equipment for zone melting thin films of InSb is described. A hot wire is used as the heat source. Experimental results are described, which show that single phase InSb films can be prepared using this equipment. (auth)

48806 (ORNL-TM-3085) PERFORMANCE TESTS ON A LABORATORY COLD ROLLING MILL. Gibson, J. R. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 19p. Dep. CFSTI.

Performance tests conducted on a small laboratory rolling mill designed for processing small quantities of isotopically pure metals are described. The mill is a 4-high design with ½-in.-dia tungsten carbide work rolls. The mill was tested for ultimate thickness of both direct and sandwich rolled samples and compared with existing equipment. Some samples were measured for uniformity. Results indicate an ability to produce thinner foils than previously available and with good uniformity as well. (auth)

48807 (SRO-475-8) POWDER METALLURGY COMPACTION. Quarterly Progress Report, June 1-August 31, 1970. Schwartz, E. G.; Wilson, Kenneth L.; Hornsby, James B. (South Carolina Univ., Columbia. Coll. of Engineering). Contract AT(38-1)-475. 16p. Dep. CFSTI.

Research results indicate that compacts vibrated during manufacture are more dense than compacts made under static conditions. This observation was made at compacting pressures producing compacts of approximately 75% theoretical density (95% theoretical density compacts hid the effects of superimposed vibrations). Segregation of powder during vibration does not appear to be of concern. Powdered lead in a matrix of aluminum showed no tendency to segregate provided the compact was loaded slightly before energizing the vibrating mechanism. Slow oscillations of a die during compaction (20, 30, and 40 cpm) failed to produce a noticeable reduction in di.. wall friction. This result could be due to the slow frequencies used or perhaps even the method of interpreting data. Further work is planned in this area. (auth)

48808 MECHANICAL PROPERTIES OF NICKEL REINFORCED WITH TUNGSTEN FIBERS. Karpinos, D. M.; Umanskii, E. S.; Rudenko, V. N.; Tuchinskii, L. I.; Dorfeev, Yu. G. (Inst. of Materials Science, Kiev. Inst. of Strength of Materials, Kiev. Novocherkassk Polytechnic Inst., USSR). Strength Mater. (USSR) (Engl. Transl.); No. 1, 74-7(Jul 1969).

Translated from Probl. Prochnosti; No. 1, 78-81(Jul 1969).

Preparation and properties of composites comprising a Ni matrix reinforced by W wires are described. The material was prepared by pressing Ni plates layered with W grids at high pressures and temperatures. (J.R.D.)

48809 ELECTROMETALLURGY. Proceedings of the Extractive Metallurgy Division Symposium Held in Cleveland, Ohio, December 2-3, 1968. Henrie, Thomas A.; Baker, Don H. Jr. (eds.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1969). 366p. (CONF-681204).

Eighteen papers were presented at the symposium. Separate abstracts were prepared for two papers. Two papers were previously abstracted in NSA as 23: 14318 and 23: 22481. Papers for which no abstracts were prepared are concerned with mineral resources, electrorefining of metals in aqueous solutions, electrowinning Cu and Ti, Mg production, explosion bonded joints, current density, electrowinning Zn, and design of electrolytic metal production cells. (J.R.D.)

For abstracts of individual papers see: 48810 and 48811.

48810 APPLICATION OF MOLTEN SALT ELECTROLYSIS IN MODERN TECHNOLOGY. Grjotheim, Kai; Krohn, Conrad (Technical Univ. of Norway, Trondheim). pp 5-42 of Electrometallurgy. /Henrie, Thomas A. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1969).

From Symposium on Electrometallurgy, Cleveland, Ohio. See CONF-681204.

A present trend seems to be the application of molten salt electrolysis also to processes other than the classical electrowinning of base metals. Materials are electrorefined, electroformed, and electrodeposited from molten salt media, and new applications are being studied in the laboratories. Examples of such processes are described and recent results of investigations of problems in light metals electrowinning are presented. (auth)

48811 APPLICATION OF ELECTROMETALLURGY IN PROCESSING OF MINERALS. Rosenbaum, Joe B. (Bureau of Mines, Salt Lake City). pp 43-51 of Electrometallurgy. /Henrie, Thomas A. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1969).

From Symposium on Electrometallurgy, Cleveland, Ohio. See CONF-681204.

Despite the higher cost of thermal energy from electricity over that from fossil fuels, the ability to pinpoint the application of electricity with close control over a wide range of intensity and with freedom from contamination has resulted in widespread adoption of electrometallurgy in processing of minerals and metals. Data on metals production and the related consumption and incremental cost of electricity in electrometallurgical applications are presented. Targets for expanded use of electrometallurgical techniques are identified. (auth)

Properties Evaluations

Refer also to abstracts 49265 and 50079.

48812 (BARC-449) INTERDIFFUSION STUDIES IN ALUMINIUM-NIOBIUM ZIRCALOY-2-NIOBIUM AND ZIRCALOY-2-TUNGSTEN SYSTEMS. Patil, R. V.; Tiwari, G. P.; Agarwal, R. P. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 31p. Dep. CFSTI (U. S. Sales Only).

Intermetallic diffusion studies were carried out to establish the bonding characteristics of Zircaloy-2 with niobium and tungsten and of aluminium with niobium by making sandwich and plug type diffusion couples. X-ray and metallographic studies on diffusion couples were made to establish the phase distribution in the diffusion bond. The growth kinetics of the diffusion layer were investigated by fitting the band width in the equation, $x^n = kt$, where x, n, k, and t are band width, reaction index, reaction constant, and time of anneal respectively. The studies revealed that, where Zircaloy-2-tungsten system obeyed the parabolic relationship with n = 2, aluminium-niobium, and Zircaloy-2-niobium systems exhibited deviations from it. The temperature dependence of the diffusion reaction constant k was also established for these systems. The activation energy values for aluminium-niobium and Zircaloy-2-niobium system were found to be 25.90 and 47.58 k cal/g mole respectively. The same for Zircaloy-2-tungsten was estimated to be 16.63 k cal/g for α-phase and

64.89 k cal/g mole for β-phase. On the basis of the Kirkendall effect porosity observed in these cases, diffusion is believed to be controlled by lattice vacancies. (auth)

48813 (BMI-X-10264) LITERATURE SURVEY ON DILUTE URANIUM ALLOYS FOR SANDIA BOOSTER CONCEPT TO SANDIA CORPORATION. Fackelmann, J. M.; Bauer, A. A.; Moak, D. P. (Battelle Memorial Inst., Columbus, Ohio). Jul 1969. 81p. Dep. CFSTI.

Although data on the uranium–molybdenum system are fairly complete, many of the mechanical properties reported may have been affected by uncontrolled stress-corrosion effects which are still not fully understood. The elevated-temperature data on the uranium–niobium alloy are rather incomplete. Detailed studies on the effect of aging and strain rate on mechanical properties are lacking for the uranium–zirconium system. Although limited information suggests some potential for uranium–chromium alloys as a booster fuel, the available property data are extremely limited. A good deal of pertinent research was performed on Mulberry alloy (U-7.5 wt % Nb-2.5 wt % Zr) but this ternary alloy is complex and there are still a lot of gaps in the available data. A problem common to all of the metastable gamma alloys is that sufficient attention was not given to transformations that may be occurring during testing at elevated temperature. Hence, many of the reported data on gamma-phase alloys become suspect. (auth)

48814 (CONF-690954–, pp 22–56) METALLOGRAPHIC AND FRACTOGRAPHIC ANALYSIS OF STAINLESS STEEL SPECIMENS AFTER LOW-CYCLE FATIGUE TESTING. Filer, E. W.; Rau, R. C. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

From Technical papers of the 23rd metallographic group meeting held September 11–12, 1969, San Francisco, California.

The metallographic and fractographic analysis of specimens tested under low-cycle fatigue conditions involved: characterization of the fractured surface; characterization of the fracture mode; and characterization of the microstructure. The material tested was fully annealed Types 304, 316, and 348 stainless steel. Specimens were tested in air at various strain rates and strain ranges at elevated temperatures. The characterization of the fracture surface was obtained using optical and electron microscopy. Plots of crack growth rate versus fatigue cycles showed that strain rate (and hence frequency) has only a small effect on the crack propagation rate, whereas the strain range is shown to be the primary rate controlling parameter in the evaluation of Type 304 stainless steel. Fracture modes were studied by using longitudinal cross sections showing the crack initiation point and final fracture area of the fatigue specimens. The mode of crack initiation, crack propagation, and final fracture were identified for three materials, two temperatures, three strain rates, and also for tests with various strain wave forms and hold periods at peak strain. Optical and electron microscopy were used to characterize the microstructure by studying the grain boundary phase, intragranular phases, and subgrain formation developed during testing. The grain boundary phase was identified as $M_{23}C_6$ and is predominantly a chromium carbide in Type 304 and 316 stainless steel; the intragranular phase has not been identified because of its small size. Transmission electron microscopy revealed the formation of numerous subgrains at 650°C for the stainless steels evaluated. (auth)

48815 (CONF-690954–, pp 57–71) AUTORADIOGRAPHIC INVESTIGATION OF TRITIUM SEGREGATION IN STAINLESS STEEL. Downs, G. L.; Braun, J. D.; McWilliams, R. C. (Mound Lab., Miamisburg, Ohio.).

From Technical papers of the 23rd metallographic group meeting held September 11–12, 1969, San Francisco, California.

The segregation of tritium in Type 304 stainless steel was investigated by autoradiographic techniques. Variations in tritium concentration due to defect structure, precipitated phases, and microsegregation of alloy components were observed. The diffusivity of tritium in the metal appeared to be enhanced by the defect structure. The autoradiography was accomplished using high resolution liquid emulsion and a new strippable emulsion. The strippable emulsion enabled in-situ autoradiographs to be evaluated without interference from etching effects on the sample surface. (auth)

48816 (CONF-690954–, pp 72–129) HOT CRACKING IN WELDMENTS OF HAYNES ALLOY NO. 25. Tucker, P. A.; Cartmill, W. B. (Mound Lab., Miamisburg, Ohio).

From Technical papers of the 23rd metallographic group meeting held September 11–12, 1969, San Francisco, California.

Metallographic examination of weldments produced by tungsten inert gas welding of Haynes alloy No. 25 gave evidence of what appeared to be intergranular cracks in the heat-affected zone. This condition was found to result from pull-out of a brittle material during metallographic polishing. When careful metallographic procedures were developed resulting in retention of the intergranular material, it was recognized as the product of a liquation reaction. Segregated carbide precipitates caused melting and hot cracking in the grain boundaries adjacent to the weld pool by means of a multicomponent eutectic reaction. Resolidification of the liquid in the grain boundaries formed two distinct phases which were hard and brittle. These were identified by electron microprobe x-ray analysis as a carbide phase and a cored solid solution phase. The microstructural characteristics of the base metal indicated that the problem occurred as the result of improper thermal and mechanical treatment of the alloy. (auth)

48817 (IS-T-398) LOW-TEMPERATURE SPECIFIC HEAT OF CERIUM AND CERIUM–YTTRIUM ALLOYS. Panousis, Nicholas Theodore (Ames Lab., Iowa). Aug 1970. Contract W-7405-eng-82. 62p. Dep. CFSTI.

Thesis.

The low temperature specific heat of α-cerium free from other allotropic modifications has been measured for the first time at standard pressures. The low temperature data are represented by the equation: $C = 9.79T + (12/5)\pi^4 R(T/117)^3$ where C is in mJ/mole-deg K. The low temperature specific heats of a nearly pure β-cerium sample (91% β – 9% α) and six β-stabilized Ce–Y alloys were also determined between 2.5 and 20°K. It was found that all six alloys showed magnetic ordering characteristic of β-cerium; the ordering temperatures were found to be linearly dependent on the cerium concentration. The magnetic specific heat of β-cerium was found to depend on the cube of the absolute temperature in agreement with the prediction of spin wave theory for an antiferromagnetic material. The entropy associated with the magnetic ordering was found to be R ln 2, which was explained in terms of hexagonal crystal field splitting. The two excited doublets resulting from the hexagonal crystal field were estimated to be 85 ± 5 and 110 ± 10°K above the ground state. (auth)

48818 (UCRL–19056) CORRELATIONS BETWEEN HIGH-TEMPERATURE CREEP BEHAVIOR AND STRUCTURE. Bird, James E.; Mukherjee, Amiya K.; Dorn, John E. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1969. Contract W-7405-eng-48. 186p. (CONF-690724–1). Dep. CFSTI.

From Conference on Quantitative Relation Between Properties and Microstructure, Haifa, Israel.

Creep of metals and alloys at high temperatures is usually diffusion-controlled. Nevertheless, the creep behavior is often sensitive to various structural and substructural details. The secondary creep rates, $\dot{\epsilon}_s$, of all coarse-grained fcc metals are given by $\dot{\epsilon}_s = 2.5 \times 10^8 (DGb/kT)(\sigma/G)^n$ where D = the diffusivity, G = the shear modulus of elasticity, b = the Burgers vector, kT = the Boltzmann constant times the absolute temperature, and σ = the applied tensile stress. The constant n increases from 4.4 for Al, to 5.3 for Ag in a consistent manner with increasing value of Gb/Γ where Γ is the stacking fault energy. Whereas, many alloys give the same trends, others in which the velocity of glide of dislocations is limited by solute atom diffusion, give $\dot{\epsilon}_s \approx 0.5 (DGb/kT)(\sigma/G)^3$. At the steady state the substructure consists of subgrains demarked by low-angle boundaries and more or less randomly meandering dislocations within the subgrains. The density, ρ, of dislocations during steady state creep depends only on the applied stress and is given by the same relationship that applies to metals during low-temperature strain hardening, namely $(\sigma/2) = 0.6\ Gb\sqrt{\rho}$. The subgrain diameter increases almost linearly with G/σ for examples of creep controlled by the dislocation climb mechanism. Alloys that do not undergo initial straining do not exhibit the usual primary stage of transient creep. The decreasing creep rate that is observed after initial straining seems to arise as a result of dispersal of dislocation entanglements rather than to a decrease in the mobile dislocation density. Recent advances in developing a theory for transient stage of creep will be discussed. The effects of grain size, grain boundary shearing, and dispersions on high temperature creep are reviewed. Consideration is given to the implications of creep behavior for understanding the phenomenon of superplasticity. (auth)

48819 (Y-1732) ANOMALOUS MECHANICAL PROPERTIES OF URANIUM-7.5 WEIGHT PERCENT NIOBIUM-2.5 WEIGHT PERCENT ZIRCONIUM ALLOY. Oakes, R. E. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 22 Sep 1970. Contract W-7405-eng-26. 36p. Dep. CFSTI.

Abnormal mechanical properties in uranium-7.5 weight percent niobium-2.5 weight percent zirconium alloy (such as nonlinear "elasticity", rubber-like amounts of "elastic" spring back, and large amounts of mechanical hysteresis) have been examined in uniaxial tension and compression with respect to stress, strain,

and aging. The results of these mechanical tests indicate the occurrence of a stress-induced phase transformation in both the as-quenched and aged alloy. Volumetric, resistance, and microstructural changes which occur under stress in the alloy further substantiate the occurrence of such transformation. (auth)

48820 (ZJE-86) Al-Mg-Si ALLOY AS A STRUCTURAL MATERIAL FOR HEAVY-WATER TANK OF THE FIRST CZECHOSLOVAK NUCLEAR POWER PLANT. Jicinsky, P. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 20p. Dep. CFSTI (U. S. Sales Only).

The Al-Si-Mg alloy was evaluated as a structural material for a heavy-water reactor tank. The main characteristics of this material and weld-joints are mentioned. Mechanical properties of this alloy are discussed. (auth)

48821 SURFACE IONIZATION. V. DESORPTION OF U NEUTRALS FROM W SURFACES. Smith, David H. (Oak Ridge National Lab., Tenn.). J. Chem. Phys.; 53: 299-301(1 Jul 1970).

The mean residence time of U neutrals on hot polycrystalline tungsten surfaces has been determined as a function of surface temperature. The desorption parameters for U° were determined from the relationship $1/\tau = \omega_0 \exp(-E_a/kT)$ and found to be $\omega_0 = (9.5 \pm 4.5) \times 10^{11}$ sec^{-1} and $E_a = 5.85 \pm 0.10$ eV. Oxygen contamination was found to have a profound effect on the W surface, with E_a being a sensitive function of the amount of oxygen present. (auth)

48822 DAMPING OF INTERSTITIAL ATOMS IN bcc METALS. Wert, C. A. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. J. Phys. Chem. Solids; 31: 1771-83(Aug 1970).

The internal friction of the bcc metals containing dissolved carbon, nitrogen, oxygen, and hydrogen is reviewed with special attention given to diffusion in these alloys. Three aspects of internal friction are considered: (a) the ideal Snoek effect, (b) the damping peaks associated with phase transformations and (c) the thermodynamics of small clusters of interstitials. (auth) (UK)

48823 THERMODYNAMIC PROPERTIES OF INTERSTITIAL SOLID SOLUTIONS BY RELAXATION METHODS. Alefeld, G.; Voelkl, J.; Tretkowski, J. (Kernforschungsanlage, Juelich, Ger.). J. Phys. Chem. Solids; 31: 1765-9(Aug 1970).

By elastic relaxation methods the derivative $(\partial\mu/\partial\rho)_T$ of the chemical potential of solutes can be determined absolutely as a function of temperature and density ρ. Therefore useful parameters which characterize the solubility of gases in metals or which determine phase transitions of solutes can be found by elastic relaxation methods. As an example experiments on hydrogen in niobium are discussed. On the basis of experimental parameters (trace of the elastic dipole moment tensor, critical density, critical temperature) it will be argued that the attractive interaction of H in Nb, which is responsible for the phase transition, is of elastic nature. (auth) (UK)

48824 INTERNAL FRICTION OF Nb-H ALLOYS. Wert, Charles (Univ. of Illinois, Urbana); Thompson, Donald ; Buck, Otto. J. Phys. Chem. Solids; 31: 1793-8(Aug 1970).

A series of seven major peaks in the acoustical absorption spectrum of Nb-H alloys was seen between 20 to 400°K. Some of these are attributed to effects that occur in the bcc solid solution, others to phenomena associated with the hydride. (auth) (UK)

48825 MUTUAL INTERACTIONS OF THORIUM, NICKEL, AND BISMUTH IN Th-Ni-Bi SOLUTIONS. Smith, F. J.; Ferris, L. M. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 32: 2863-8(Sep 1970).

Thorium and nickel, dissolved in liquid bismuth, were found to interact with each other and with the solvent to form a solid ternary compound of the apparent composition $ThNiBi_4$. This interaction was studied, at 50° intervals, over the temperature range of 550 to 700°C. At each temperature studied the joint solubility of thorium and nickel could be expressed as a mole fraction product, $K_{sp} = X_{Th}X_{Ni}$. The variation of K_{sp} with temperature could be expressed as $\log K_{sp} = 1.115 - 6397/T(°K)$. The standard free energy of formation of $ThNiBi_4$ was estimated to be -51 kcal/mole at 550°C. (auth) (UK)

48826 THERMAL CONDUCTIVITY OF METALS AT HIGH TEMPERATURES BY THE JAIN AND KRISHNAN METHOD. V. ZIRCONIUM. Jain, S. C. (Solid State Physics Lab., Delhi); Sinha, V.; Reddy, B. K. J. Phys., D (London); 3: 1359-62 (Sep 1970).

Using the modified Jain and Krishnan method, the thermal conductivity of zirconium was measured in the temperature range 1100 to 1500°K. The thermal conductivity was found to increase with temperature. The electrical resistivity of zirconium and the total emissivity of ZrO were also measured in the temperature range 1050 to 1500°K and are reported. (auth) (UK)

48827 APPARENT SUPERHEATING IN SODIUM AND POTASSIUM. Arlaud, J. C. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Gen. Therm.; 9: 899-904(Jul-Aug 1970). (In French).

Sodium and potassium may not show any specific characteristics with regard to the superheating phenomenon. A historical report is made on the expulsion tests which led different authors to present these two fluids as singular ones. Boiling delays of several hundreds of Celsius degrees can be explained by taking into account the expansion of the fluid prior to the apparition of the gaseous phase. This is no more a true superheating specific to the fluids tested, but the influence of interference effects connected to the test conditions. An explanation of forced convection superheating is proposed. (auth) (France)

48828 KINETICS OF THE CARBIDING REACTION: TANTALUM CARBIDE. Johansen, H. A. (Westinghouse Research Labs., Pittsburgh). Planseeber. Pulvermet.; 18: No. 1, 16-27(Mar 1970).

Direct weighing measurements of the carbiding of tantalum sheet and wire in various gases containing interstitial N_2, O_2, and H_2 were made. Parabolic rate behavior was observed. An equivalent single phase diffusion was found from simple theory in argon $D_{equiv} = 2.67 \exp(-101{,}000/RT)$ and in ^{30}Ar vol % N_2 $D_{equiv} = 4.9 \times 10^{-5} \exp(-34{,}000/RT)$ cm^2/sec. The best gas carbiding medium was found to be ^{10}Ar vol % C_2H_2 which was somewhat superior to the ^{30}Ar vol % N_2 at 2500°C and far superior to Ar alone. A new treatment of two phase diffusion was introduced using the time to the knee in the weight gain versus root time plots. The diffusion constants for $TaC(D_1)$ and $Ta_2C(D_2)$ in argon at 2600°C were: $D_1 = 4.75 \times 10^{-9}$ cm^2/sec and $D_2 = 2.97 \times 10^{-7}$ cm^2/sec. They were in fair agreement with the simple theory values and the values of R. Resnick, et al. derived from layer growth measurement. Bend strength values for gas carbided material were found to be about twice those of powder metallurgy carbide at room temperature and for temperatures up to 1600°C were about 1.5 times. (auth)

48829 INTERGRANULAR BRITTLENESS STUDIES IN TUNGSTEN USING AUGER SPECTROSCOPY. Joshi, A.; Stein, D. F. (Univ. of Minnesota, Minneapolis). Met. Trans.; 1: 2543-6(Sep 1970).

The present investigation was aimed at understanding the problem of brittleness in powder metallurgy tungsten by utilizing Auger Electron Emission Spectroscopy as a tool for direct chemical analysis of fracture surfaces. Substantial segregation of phosphorus to the grain boundaries was observed in tungsten and the concentration of phosphorus could be related to the ductile-brittle transition temperatures. The amount of segregation was dependent upon the grain size—the larger the grain size, the greater the concentration of phosphorus at the grain boundary and the associated embrittlement. (auth)

48830 THERMOELECTRIC PROPERTIES OF WIRES MADE OF TUNGSTEN MONOCRYSTALS. Druzhinina, I. P.; Fraktovnikova, A. A.; Vladimirskaya, T. M.; Mel'nikova, L. V. Meas. Tech. (USSR) (Engl. Transl.); No. 3, 378-9(Mar 1970).

Translated from Izmer. Tekh.; No. 3, 42-4(Mar 1970).

Tungsten wire was studied after subjecting the wire to annealing at 900 to 2200°C, and to cyclic processing. It was found that the monocrystalline wire is not structurally or thermoelectrically stable at 1300°C. At high temperatures and subject to repeated heating, the wire, classified as a cermet, is more stable than the monocrystalline material. (J.R.D.)

48831 DIFFUSIONAL RELAXATION OF H AND D IN V AND Nb. Voelkl, J.; Schumann, G.; Alefeld, G. (Kernforschungsanlage, Juelich, Ger.). J. Phys. Chem. Solids; 31: 1805-9(Aug 1970).

The properties of the elastic diffusional relaxation processes of H and D in V and Nb are summarized. Results on the diffusion coefficients for both isotopes in these metals are also presented. (auth) (UK)

48832 INTERNAL FRICTION DUE TO LONG-RANGE DIFFUSION OF HYDROGEN AND DEUTERIUM IN VANADIUM. Cantelli, R.; Mazzolai, F. M.; Nuovo, M. (Consiglio Nazionale delle Ricerche, Rome). J. Phys. Chem. Solids; 31: 1811-17 (Aug 1970).

The long-range diffusion (Gorsky effect) of hydrogen and deuterium in vanadium was investigated by internal friction measurements in the temperature range from 110 to 930°K; the vibration frequencies are included between 6 and 68 Hz. The diffusion coefficient of hydrogen and deuterium obeys an exponential law in a

wide temperature range, the preexponential factors and the activation energies being: $D_{OH} = (4.4 \pm 1.5) \times 10^{-4}$ cm²/sec, $D_{OD} = (3.1 \pm 0.8) \times 10^{-4}$ cm²/sec, $W_H = (0.059 \pm 0.007)$ eV, $W_D = (0.073 \pm 0.006)$ eV. (auth) (UK)

48833 ELASTIC AND MAGNETOELASTIC EFFECTS IN RARE EARTH METALS. Moran, T. J.; Luethi, B. (Rutgers–The State Univ., New Brunswick, N. J.). J. Phys. Chem. Solids; 31: 1735-40(Aug 1970).

The elastic and magnetoelastic properties of Gd, Tb, Dy, and Ho are described as a function of temperature and magnetic field in the paramagnetic and ferromagnetic phases. It was found that the longitudinal sound velocity along the c-axis exhibits an ^2H field dependence in the paramagnetic state. In the ferromagnetic region it was found that Gd, Dy, and Tb exhibited several competing magnetoelastic effects for shear sound waves propagating along the c-axis. A qualitative explanation of these effects is presented. (auth) (UK)

48834 CONTRIBUTION TO THE STUDY OF INTERNAL FRICTION PEAKS ASSOCIATED WITH DISLOCATIONS IN VARIOUS METALS, AND THEIR RELATIONS WITH COLD-WORK. de Fouquet, J.; Boch, P.; Petit, J.; Rieu, G. (Univ. of Poitiers, France). J. Phys. Chem. Solids; 31: 1901-6(Aug 1970).

Peaks of internal friction associated with dislocations were studied under the same experimental conditions between 77 to 700°K, in the frequency range 5 to 50 kHz, on various metals: copper, aluminum, nickel, zirconium, and molybdenum. Experimental results show a close relationship, characteristic of each metal, between the height of peaks and the amount of prestrain at room temperature. These relations and the influence of successive annealings after cold-work, or of the additional elements for zirconium, confirm the consequence of internal stresses on these peaks, in accordance with the Seeger–Paré theory for Bordoni peaks, and with the Hasiguti first model for peaks observed at higher temperature. (auth) (UK)

48835 DISLOCATION RELAXATION IN SINGLE CRYSTALS OF bcc METALS. Gibala, R.; Korenko, M. K.; Amateau, M. F.; Mitchell, T. E. (Case Western Reserve Univ., Cleveland). J. Phys. Chem. Solids; 31: 1889-99(Aug 1970).

The behavior of the α dislocation relaxation peak in bcc metals has been investigated for various orientations of high purity crystals which were deformed in tension at temperatures in the range 77 to 450°K. The effects of substitutional alloying, interstitial impurities, and strain aging were also examined. These results coupled with results obtained by other investigators support a dislocation breakaway model as a likely mechanism of the α peak. (auth) (UK)

48836 FREQUENCY DEPENDENCE OF DISLOCATION DAMPING IN NIOBIUM. Gangúly, B. K.; Baker, C.; Birnbaum, H. K. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. J. Phys. Chem. Solids; 31: 1877-81(Aug 1970).

The frequency dependence of dislocation damping in niobium was measured in the megahertz frequency range at 293 and 80°K. The results are interpreted in terms of an elastic string dislocation mechanism and in terms of a dislocation motion mechanism based on the movement of kinks. Both models appear to be consistent with the experimental results. The elastic string mechanism leads to a viscous damping constant of 1.1×10^{-4} dyn sec cm^{-2} at 293°K. The kink motion mechanism leads to a ratio of the kink density/kink damping constant of 0.3×10^{19} cm dyn^{-1} sec^{-1}. (auth) (UK)

48837 INTERNAL FRICTION IN LOW TEMPERATURE IRRADIATED bcc METALS. Hivert, V.; Pichon, R.; Bilger, H.; Bichon, P.; Verdone, J.; Dautreppe, D.; Moser, P. (CEN, Grenoble, France). J. Phys. Chem. Solids; 31: 1843-55(Aug 1970).

Internal friction peaks observed on irradiated iron and molybdenum are presented. An interpretation is proposed, which supposes a one-interstitial model. (auth) (UK)

48838 SOLUBILITY OF CERIUM IN COPPER AND ITS EFFECTS ON THE PROPERTIES OF BRASSES. Dulsemaliev, U. K.; Presnyakov, A. A.; Saparov, K. S.; Kozhamberdin, N. A. (Kazakh Polytechnic Inst., Alma-Ata, USSR). Metalloved. Term. Obrab. Metal.; No. 2, 36-43(1970). (In Russian).

The solubility of Ce in Cu and the effects of ferric Ce on the structure and properties of brasses were studied. Addition of 0.03 to 0.1% of Ce increased the plasticity of Cu and its alloys. Small addition of Ce to brass increased the plasticity significantly. (tr-auth)

48839 SOLUBILITY OF ZIRCONIUM, MOLYBDENUM, AND NIOBIUM IN α-URANIUM. Gomozov, L. I.; Lyutina, E. M.; Ivanov, O. S. Izv. Akad. Nauk SSSR, Metal.; No. 2, 210-15(Mar-Apr 1970). (In Russian).

The solubility of Mo, Nb, and Zr in alpha-phase U at 550 to 660°C was studied by optical and electron microscopy and by the relation between the composition and hardness of cold-formed and annealed alloys of eutectolytic U with Mo, Nb, and Zr. The solubility of alpha-U diminishes as follows: U–Zr, U–Nb, U–Mo, and in all cases did not exceed 0.5 at. %. The hardness of alpha-solid solutions increased in the same order. (R.V.J.)

48840 EFFECT OF TEMPERATURE ON PLASTICITY OF POLYCRYSTALLINE TUNGSTEN OF INDUSTRIAL PURITY. Gordienko, L. K.; Kopetskii, Ch. V.; Panovko, V. M. Izv. Akad. Nauk SSSR, Metal.; No. 2, 190-8(Mar-Apr 1970). (In Russian).

Experiments were conducted with polycrystalline W containing different quantities of impurities. It was determined that impurities did not affect the melting characteristics nor crystal structure of the metal. Also, the yield strength of industrially pure polycrystalline W at 300 to 600°C proved to be similar to that of pure W monocrystals. (R.V.J.)

48841 REDUCTION OF CARBON OXIDE IN LIQUID MOLYBDENUM. Kozina, L. N.; Revyakin, A. V.; Samarin, A. M. Izv. Akad. Nauk SSSR, Metal.; No. 2, 116-18(Mar-Apr 1970). (In Russian).

The interaction of carbon oxide with liquid Mo at temperatures close to the melting points was studied. The constant of reaction equilibrium was determined as: CO = [C] + [O] $K_p = (N_C N_O/P_{CO}) = 1.51 \cdot 10^{-5}$ $[(a_T d/a_T m)^2]$ and the product of carbon and oxygen activity coefficients was $\gamma_C f_O = 0.045$. (tr-auth)

48842 DIFFUSION OF PHOSPHORUS IN VANADIUM AND ZIRCONIUM. Vandyshev, V. A.; Panov, A. S. Izv. Akad. Nauk SSSR, Metal.; No. 2, 231-4(Mar-Apr 1970). (In Russian).

Radiometric analysis was used for measuring the diffusion of P in V at 1200 to 1450°C and in Zr at 950 to 1200°C. Phosphorus diffusion in V basically is volumetric in character, and in Zr, boundary diffusion influences the process. (tr-auth)

48843 CERTAIN PHYSICOCHEMICAL PROPERTIES OF ALLOYS WITH 90 WEIGHT PERCENT TUNGSTEN WITH MOLYBDENUM, NIOBIUM, AND TANTALUM. Pryakhina, L. I.; Ozhimkova, O. V. Izv. Akad. Nauk SSSR, Metal.; No. 2, 224-7(Mar-Apr 1970). (In Russian).

Studies of the density of W–Mo–Nb–Ta alloys with 90 wt % W showed that the density varies from 17.1 to 18.5 g/cm³. It is shown that, at room temperature, W-base alloys with Nb, Ta, or Nb–Ta increase in hardness from 344 to 404 kg/mm² with Mo additions. Studies of the thermal stability of four-component alloys at temperatures from 20 to 1100°C showed that at 1100°C the ternary alloys W–Nb–Ta had the greatest stability. (tr-auth)

48844 HEAT-RESISTANT PROPERTIES OF CERTAIN PURE METALS. Sokolov, L. D.; Solenov, V. M.; Skudnov, V. A.; Shneiberg, A. M.; Gladkikh, A. N. Izv. Akad. Nauk SSSR, Metal.; No. 2, 181-9(Mar-Apr 1970). (In Russian).

The polycrystalline lanthanide group and other metals (Bi, Cd, Co, Er, Ga, Ho, In, La, Lu, Nd, Pr, Sc, Tb, Tl, Y, and Zn) were studied for their resistance to uniaxial deformation and plasticity at various temperatures and deformation rates. (tr-auth)

48845 DISTRIBUTION AND EFFECTS OF GAS POROSITY IN WELDS IN CVD TUNGSTEN. Lundin, C. D. (Univ. of Tennessee, Knoxville); Farrell, K. Weld. J. (N. Y.); 49: 461s-4s (Oct 1970).

Extensive gas porosity was found in the heat-affected zone and fusion zone of fusion welds in chemical vapor deposited tungsten. Pores were observed to nucleate and grow on grain boundaries in the heat-affected zone. The extent of pore growth depended upon the weld thermal cycle and on whether or not grain boundary migration occurred. Pore linkup in the heat-affected zone was observed in many instances, leading to the formation of heat-affected zone microfissures. Three types of pore distributions were noted in the fusion zone. Two of these, involving very small pores, were clearly associated with weld pool motion and solidification, and are believed to result from precipitation of dissolved gases during solidification of the weld pool. The remaining porosity was on a large scale and was thought to be due to entrapment of gas pores that existed before melting occurred. (auth)

48846 STRENGTH AND PLASTICITY OF TECHNICALLY PURE MOLYBDENUM EXPOSED TO A PROGRAMMED LOAD VARIATION. Strizhalo, V. A. (Inst. of Strength of Materials, Kiev). Strength Mater. (USSR) (Engl. Transl.); No. 1, 78-80 (Jul 1969).

Translated from Probl. Prochnosti; No. 1, 82-4(Jul 1969).

Results of investigations of the plasticity and strength of technically pure Mo fabricated by powder metallurgy are presented. The tests were carried out at 1600°C. An equation is included which describes the relations between the number of cycles to rupture and the relative plastic deformation in a cycle. Data on the rupture process are included. (J.R.D.)

48847 INFLUENCE OF CARBON ON THE ELASTICITY AND PROLONGED HARDNESS OF NIOBIUM AT HIGH TEMPERATURES. Nadezhdin, G. N.; Malashenko, I. S. (Inst. of Strength of Materials, Kiev. Inst. of Electrowelding, Kiev). Strength Mater. (USSR) (Engl. Transl.); No. 2, 200-1(Aug 1969).

Translated from Probl. Prochnosti; No. 2, 83-5(Aug 1969).

The effects of C on the modulus of normal elasticity and hardness of Nb at high temperatures were investigated in Nb–0.1% C alloys. It was found that diffusion processes occur at ≥ 1000°C which result in metal softening tendencies. The addition of Zr to Nb–C alloys stabilizes the C and raises the temperature at which softening starts. (J.R.D.)

Structure and Phase Studies

Refer also to abstracts 49249, 49269, and 49270.

48848 (CONF-690954-, pp 172-90) ELEVATED TEMPERATURE METALLOGRAPHY OF β–Pu. Arrowsmith, H. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Technical papers of the 23rd metallographic group meeting held September 11–12, 1969, San Francisco, California.

Elevated temperature metallographic techniques were developed to determine the grain size of beta plutonium. A significant difference between the grain size of beta transformed from alpha and beta transformed from gamma was observed. The average grain size of beta transformed from alpha was less than 5 μ, which can account for the superplasticity that is observed. The average grain size of beta formed from gamma, on the other hand, was greater than 50 μ, which with its limited slip can account for the brittleness that is observed in this beta. (auth)

48849 (IS-T-416) NEODYMIUM–NEODYMIUM HYDRIDE PHASE SYSTEM. Poskie, Thomas John (Ames Lab., Iowa). May 1970. Contract W-7405-eng-82. 32p. Dep. CFSTI.

Thesis.

The neodymium-neodymium hydride phase system has been studied. Pure neodymium has a double hexagonal crystal structure at room temperature. It transforms to a body centered cubic structure at 857 and melts at 1018°C. The addition of hydrogen to neodymium produces two eutectoid reactions. The first of these occurs at 813°C and 12.5 at. % hydrogen. The second eutectoid reaction exists at 22.2 at. % hydrogen. The solubility of hydrogen in neodymium increases rapidly with temperature while the composition of the neodymium hydride phase changes very little with temperature. A previously unreported phase was found to exist above the eutectoid reaction at 672°C. This phase is an intermediate stable phase which exists between the double hexagonal and the body centered cubic phases at higher hydrogen contents. (auth)

48850 PHASE DIAGRAM OF DYSPROSIUM–TELLURIUM SYSTEM. Abrikosov, N. Kh.; Zinchenko, K. A.; Eliseev, A. A. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 720-5(Apr 1970). (In Russian).

The phase diagram of the dysprosium–tellurium system, in the range of concentrations from 0 to 100 at. % Te was studied. The crystal structures were confirmed and the phase periods DyTe, Dy_2Te_3, Dy_4Te_7, $Dy_2Te_3(Dy_4Te_5)$, and $DyTe_{2-x}(Dy_4Te_{11})$ were calculated. The compound Dy_3Te_4 with the structure of Type Sc_2S_3 was found and the continuous series of solid solutions between Dy_3Te_4–Dy_2Te_3 were established. The displacement of stoichiometric compositions of dysprosium polytellurides in the direction of the metal was confirmed. (tr-auth)

48851 PHASE DIAGRAM OF THE CADMIUM-ANTIMONY SYSTEM. Yarembash, E. I.; Korsakova, M. D.; Eliseev, A. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 732-8(Apr 1970). (In Russian).

Microstructure, thermal, and x-ray-phase analyses were made of the stable and also metastable phase diagrams of the Cd–Sb system. The existence of the following compounds was verified by x-ray analysis: CdSb (stable phase) at the congruent melting point of 458°C crystallized in rhombic syngony of A equals 6.471 Å, B equals 8.244 Å, and C equals 8.521 Å; Cd_4Sb_3 (metastable phase) at melting point of 431°C; and Cd_2Sb_2 (labile phase). (tr-auth)

48852 CERIUM–IRON–SILICON SYSTEM. Bodak, O. I.; Gladyshevskii, E. I.; Kardash, A. V.; Cherkashin, E. E. (Lvov State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 1069-72 (Jun 1970). (In Russian).

X-ray and metallographic methods were used in studies of the phase equilibrium diagram for the ternary system of Ce–Fe–Si with 0 to 33.3 at. % of Ce at 800°C and with 33.3 to 100 at. % Ce at 400°C. The existence of two compounds, $CeFe_2Si_2$ and Ce_2FeSi_3, was confirmed, and two new compounds, $CeFeSi_2$ with a rhombic structure of Type $CeNiSi_2$ (A equals 4.094 Å, B equals 16.854 Å, and C equals 4.031 Å) and CeFeSi with the tetragonal structure of the new type (A equals 4.062 A and C equals 6.752 Å), were discovered. The solubility of Fe in $CeSi_2$ (12 at. %) and Si in $CeFe_2$ (10 at. %) was measured. An increase of Fe content in compounds enhances the electrical ionization of silicon atoms. (tr-auth)

48853 INVESTIGATION OF THE PHASE DIAGRAM OF TELLURIUM–YTTERBIUM SYSTEM. Abrikosov, N. Kh.; Zinchenko, K. A.; Eliseev, A. A. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 1172(Jun 1970). (In Russian).

The phase diagram of the Te–Yb system at various concentrations and certain physical properties of ytterbium monotellurides were studied. The temperature dependence of electrical conductivity of ytterbium tellurides was studied at temperatures to 1300°K. It was shown that electrical conductivity increases with an increase of temperature due to the increased concentration of current carriers. (tr-auth)

48854 POLYGONIZATION AND CRYSTAL STRUCTURE OF BERYLLIUM. Taranenko, I. A.; Tikhinskii, G. F.; Kornienko, L. A.; Nikolaenko, A. A.; Papirov, I. I. (Physical-Tech. Inst., Kiev). Fiz. Metal. Metalloved.; 29: 619-24(Mar 1970). (In Russian).

The effects of temperature and stress, annealing conditions, and material impurities on the polygonization and crystal structure of Be were studied. Be polygonization is manifested most strongly in metal rolled at low pressure and at temperatures from 600 to 700°C. To obtain relatively uniform crystal structure in highly stressed Be it is necessary to anneal at 850 to 900°C for approximately one minute. (tr-auth)

48855 Fe–Ho BINARY SYSTEM. Roe, G. J.; O'Keefe, T. J. (Univ. of Missouri, Rolla). Met. Trans.; 1: 2565-8(Sep 1970).

The Fe–Ho phase diagram was determined on the basis of dat. obtained by x-ray diffraction, metallographic, and differential thermal analysis techniques. Since emphasis was centered in the region where intermetallic compounds predominate, neither the iron nor holmium terminal regions were included in this study. Eutectic reactions were found to occur at 16.5 wt % Fe and 875°C, 61 wt % Fe and 1284°C, and 79 wt % Fe and 1338°C. The congruent melting points of the compounds Ho_6Fe_{23} and Ho_2Fe_{17} were found to be 1332 and 1343°C, respectively. Two other intermetallic compounds were found, $HoFe_2$ and $HoFe_3$, which had peritectic decomposition temperatures of 1288 and 1293°C, respectively. (auth)

48856 EFFECT OF SUPERHEAT ON THE STRUCTURE AND PHASE COMPOSITION OF ALUMINUM–TUNGSTEN ALLOYS. Varich, N. I.; Lyukevich, R. B. Izv. Akad. Nauk SSSR, Metal.; No. 2, 216-19(Mar-Apr 1970). (In Russian).

During the annealing of Al alloyed with 2.8, 4.5, and 5.0 wt % W at temperatures close to the melting points, a large number of finely dispersed Al_4W phases were observed which ordinarily do not form at crystallization equilibrium in alloys of such composition. An Al_4W phase occurred during quenching of the alloys. During quenching from the liquid state, Al–W alloys exhibited an increase of saturation of solid solution as a function of the superheating temperature. (R.V.J.)

48857 PHASE STRUCTURE OF Ti_3Al–Nb ALLOYS. Nartova, T. T.; Sopochkin, G. G. Izv. Akad. Nauk SSSR, Metal.; No. 2, 220-3(Mar-Apr 1970). (In Russian).

Phase diagrams of quasi-binary cross section of Ti_3Al–Nb were constructed using thermal micro- and x-ray-structure analysis. The alloys crystallized with the formation of continuous series of solid solutions based on beta-solid solution of the Ti–Al and Nb systems. Alloys containing up to 48% Nb undergo the phase transformations in solid state. Similar transformations take place in binary Nb–Ti alloys. Alloys with 50% Nb and above do not undergo the transformation in the solid state. Alloys of Ti_3–Al with Nb undergo a significant reduction of temperature of phase transformations and stabilize in beta-solid solution. (tr-auth)

48858 TRANSMISSION ELECTRON MICROSCOPY OF MOLYBDENUM DEFORMED IN THE TEMPERATURE RANGE 20 TO 940°C. Igarashi, Tadashi; Karashima, Seiichi; Oikawa, Hiroshi (Tohoku Univ., Sendai). Technol. Rep. Tohoku Univ.; 35: 1-13(Jun 1970).

The microstructure of polycrystalline molybdenum of commercial purity deformed in tension up to 13%, was investigated. It was found that in room-temperature deformation, well-defined cell-structures are observed at strains over 12%, though dislocation loops are observed at strains over 3%. The strain at which well-defined cell-structures can be observed becomes smaller as the deformation temperature rises to about 200°C, where the cell is formed at 1.5% strain. At temperatures over

200°C the cell-formation strain becomes gradually larger as the temperature rises. Nearly all the sub-boundaries or cell-walls consist of dislocation loops. Sub-boundaries consisting of dislocation networks are observed in some regions of the specimen deformed at 850 and 940°C. Most of the subgrains are not equiaxed, elongating in the direction of ⟨110⟩. (auth) (Japan)

Radiation Effects

Refer also to abstracts 49248 and 50083.

48859 (BNWL-1368) HAZARDS ANALYSIS FOR THE BATTELLE-NORTHWEST EBR-II/TREAT TRANSIENT IRRADIATION TEST SERIES. Culley, G. E.; Sheppard, D. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 82p. Dep. CFSTI.

The experimental equipment used and analysis of potential hazards involved in the EBR-II/TREAT series of transient irradiations to be conducted in support of the Fast Flux Test Facility (FFTF) fuel development program are reported. Approximately sixteen transient irradiations in TREAT will be conducted on prototypic FFTF fuel pins previously irradiated in EBR-II to burnups of 10,000 and 50,000 MWd/mtm. A hazards analysis was conducted on the maximum burnup fuel pin for both the expected and maximum accident transient conditions. (auth)

48860 (CONF-690954-, pp 148-59) DIRECT OBSERVATION AND IDENTIFICATION OF TRANSMUTATION-PRODUCED SILICON IN A NEUTRON-IRRADIATED ALUMINUM ALLOY. Gehlbach, R. E.; Farrell, K.; Stiegler, J. O. (Oak Ridge National Lab., Tenn.).

From Technical papers of the 23rd metallographic group meeting held September 11-12, 1969, San Francisco, California.

A commercial Al-1% Ni alloy exposed to high fluence neutron irradiation contains a very fine dispersion of precipitate. This precipitate coarsens markedly by one-hour postirradiation annealing at progressively higher temperatures. Chemical analysis, electron diffraction and electron probe microanalysis are used to identify this precipitate as silicon produced from aluminum by the transmutation reaction with thermal neutrons $^{27}Al(n,\gamma)^{28}Al$, $^{28}Al \rightarrow {}^{28}Si + \beta$. (auth)

48861 (CONF-700421-1) EXPERIMENTAL DEVELOPMENT OF RADIATION RESISTANT 85,000 PSI YIELD STRENGTH REACTOR VESSEL LOW ALLOY STEEL FILLER METAL (PRE-IRRADIATION EVALUATION). Fortner, Edward (Babcock and Wilcox Co., Alliance, Ohio. Research and Development Div.); Hawthorne, J. R. (Naval Research Lab., Washington, D. C.); Grant, S. P. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). 18 Feb 1970. 8p. American Society of Mechanical Engineers, New York $2.00.

From ASME Metals Engineering Conference and AWS Welding Show, Cleveland, Ohio.

Small amounts of copper are known to enhance the radiation embrittlement sensitivity of alloy steel plate and weld metals at 550°F. Preirradiation data are presented from a statistical program aimed at defining composition limits of a new weld metal for quenched and tempered A543 and A542 steels based on 2-¼ Cr-1 Mo and varying copper, nickel, and manganese. As-welded plus stress relief notch ductility properties are much improved when the manganese content is kept low (0.75 percent). (auth)

48862 (KFK-1152) IN-PILE CREEP BEHAVIOR OF SEVERAL AUSTENITIC STEELS AND NICKEL ALLOYS UNDER MULTIAXIAL LOAD. Results of the Mol 2-Experiment. Closs, K. D.; Laue, H. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Dec 1969. 52p. (In German). Dep. CFSTI (U. S. Sales Only).

Tubes with an outer diameter of 7 mm, a wall thickness of 0.4 mm and a length of 45 mm have been irradiated in the Belgian Reactor BR 2 at temperatures of 600, 650, and 700°C to determine the stress-rupture-strength and the rupture-strain of these specimens. The maximum irradiation time was 4757 hr. The austenitic stainless steels and Ni-alloys examined include the German steels X8CrNiMoV Nb 1613 and X2CrNi 2025, Incoloy 800, Inconel 625, Hastelloy X, Inconel 718, and Inconel X 750. The decrease of the stress-rupture-strength caused by the irradiation was between 15% and 55% depending on the irradiation temperature and the materials used. The rupture-strain of the tested alloys was drastically reduced by the irradiation. This was attributed to the high temperature embrittlement by (n,α)-reactions. All alloys except Incoloy 800 and Hastelloy X showed rupture-strains less than 1% for at least one test temperature. (auth)

48863 (SGAE-PH-98/1970) INTERPRETATION OF GAMMASPECTROMETRIC MEASUREMENTS ON BURNT FUEL ELEMENTS. Hick, H.; Lammer, M. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). [1968]. 11p. (CONF-700701-3). Dep. CFSTI (U. S. Sales Only).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany.

Gamma spectrometry allows a nondestructive determination of the fission product and activation product content of spent nuclear fuel elements. The evaluation of a gamma spectrum and its interpretation in terms of isotope activities is a fairly accurate process which is limited in its accuracy mainly by the accuracy of the nuclear data used and the self-absorption correction. The question arises however, what meaningful interpretations in terms of reactor operation data can be given for the measured isotope activities. Theoretical attempts to calculate isotope activities from specified irradiation conditions and theoretical and practical work to infer irradiation conditions from measured isotope activities and various degrees of additional information are described. Burnup (total number of fissions) has been successfully and routinely determined from ^{137}Cs, $^{144}Ce-Pr$, $^{106}Ru-Rh$ and $^{95}Zr-Nb$ activities. $^{95}Zr-Nb$ has been used routinely to infer cooling times. ^{233}Pa has been used to calculate neutron flux and ^{233}U breeding rates at shutdown for Th-containing fuel. $^{106}Ru-Rh$ was used to determine the number of Pu-fissions. $^{137}Cs/^{134}Cs$ ratios yield information on the neutron flux level. Owing to the inaccuracy or total lack of part of the nuclear data needed for these interpretations much experimental work has still to be done to check theoretical conclusions. (auth)

48864 (UCRL-72408) STRUCTURAL EFFECTS OF NIOBIUM ION BOMBARDMENT OF NIOBIUM FOILS. Progress Report. Mohr, P. B.; Myers, B.; Brunner, W. (California Univ., Livermore. Lawrence Radiation Lab.). 16 Sep 1970. 7p. (CONF-700912-4). Dep. CFSTI.

From 5th Annual Intersociety Energy Conversion Engineering Conference, Las Vegas, Nevada.

The effects which 14 MeV neutron radiation likely to have on the engineering properties of thermonuclear reactor materials are examined. The damage mechanisms associated with fusion neutron irradiations with particular emphasis on their effect on reactor operating temperatures and service lifetimes are enumerated and compared. Difficulty is anticipated in attaining the required fluence of 14 MeV neutrons for radiation effects testing prior to the existence of the reactors themselves. This leads to consideration of other means for experimental simulation of the desired effects. An approach to simulation based on the bombardment and simultaneous testing of thin foils is favored. Such a program of evaluation has been initiated. An assessment is given of the surface physics complications which are believed to be present. The technology for the creation of representative thin foils is discussed and an outline for in-situ creep testing is presented. Electron microscopy, diffraction and x-ray production methods of specimen characterization and experiment control are considered. (auth)

48865 IRRADIATION HARDENING OF IRON. COMBINED INFLUENCE OF DOSE RATE, TEMPERATURE, CLUSTER RADIUS, AND GRAIN SIZE. Hannerz, N. E. (Oxelosunds Jarnverk, Oxelosund, Sweden). Jernkontorets Ann.; 154: 229-35(1970).

It is shown that a vacancy diffusion to grain boundaries can be applied both to annealing during irradiation and annealing subsequent to an irradiation at lower temperatures, although the latter reaction shows an apparent activation energy equal to that of volume self-diffusion. An explanation could be that the vacancies are in the form of clusters and that during annealing a layer denuded of clusters will develop at the grain boundaries and grow into the grain. The gradient will be proportional to the vacancy solubility, and thus the product of the vacancy diffusion coefficient and the gradient will equal the self-diffusion coefficient. For different reasons such a denuded layer will not form if the irradiation and the thermal annealing are applied at the same time. The theoretical treatment yields an equation predicting the increase in strength of the material as a function of temperature, time, dose rate, and grain size. As in many other cases a fine-grained material appears to be superior. The theoretical equation is tested on a steel, with good agreement between theory and experiments. (auth) (Sweden)

48866 INTERNAL FRICTION MAXIMA DUE TO RELAXATION OF POINT DEFECTS IN NEUTRON IRRADIATED ALUMINUM. Ehrensperger, K.; Fischer, V.; Kerscher, J.; Wenzl, H. (Technical Univ., Munich). J. Phys. Chem. Solids; 31: 1835-41(Aug 1970).

The internal friction and shear modulus of pure recrystallised

polycrystalline aluminum wires has been studied as a function of temperature by measurement of the logarithmic decrement of the free vibrations (64 and 200 cps) in shear strain ($\epsilon \approx 10^{-4}$) after irradiation with fast neutrons at 4.6°K. The elementary processes related to these internal friction maxima are discussed in terms of the corresponding elastic dipole tensors and the annealing model for irradiated aluminum. (auth) (UK)

48867 RADIATION RESISTANT EXPERIMENTAL WELD METALS FOR ADVANCED REACTOR VESSEL STEELS. Hawthorne, J. R. (Naval Research Lab., Washington, D. C.); Fortner, E.; Grant, S. P. Weld. J. (N. Y.); 49: 483s-60s(Oct 1970).

The effects of variable copper, nickel, and manganese contents on the notch ductility properties of a 2¼ Cr–1 Mo–0.40 Si–O .10C weld composition were investigated. The formulation of highly radiation resistant weld metal compositions suitable for quenched and tempered A543 and A542 steel is the end program objective. The study employed several 2¼ in. thick multipass submerged arc welds with <0.05 and 0.25% copper, 0.75 and 1.25% nickel, and 0.80 and 1.25% manganese contents in statistical combinations. A midrange composition variation was also evaluated. Yield strengths were 85,000 psi (minimum) after a 1150° F 8 hr stress relief. Charpy V-notch specimen irradiations were conducted in the Union Carbide Research Reactor (UCRR); the neutron fluence was 2.8×10^{19} n/cm² > 1 MeV. Very low, essentially nil sensitivity to 550° F radiation embrittlement was exhibited by the four low copper content welds. Charpy-V transition temperature increases were ≤20° F; shelf energy reductions were less than 10 ft-lb. In contrast, all high copper content welds including the midrange variation showed marked susceptibilities to radiation embrittlement; individual transition temperature increases ranged from 195 to 265° F. Pronounced embrittlement of the high copper welds was not the result of non-nuclear temperature dependent processes. Separate contributions of nickel and manganese to radiation embrittlement tendencies were not observed. Effective control over the radiation embrittlement behavior of a 2¼ Cr-1 Mo weld composition was clearly demonstrated. Optimum radiation embrittlement resistance is shown to require copper contents appreciably less than 0.16%. (auth)

Ceramics and Cermets

Refer also to abstracts 48029, 48078, and 48795.

Corrosion and Erosion

48868 (SC-RR-70-534) EVAPORATIVE EROSION OF THERMOELECTRIC ELEMENTS IN SOME THERMOELECTRIC GENERATORS. Kinney, R. D. (Sandia Labs., Albuquerque, N. Mex.). Sep 1970. 32p. Dep. CFSTI.

A model is presented, and a parametric analysis is performed on the evaporative erosion of material from thermoelectric elements during operation of some thermoelectric generators. The relative influence of parameters is noted and limitations of the model are discussed. (auth)

48869 ROOM TEMPERATURE OXIDATION OF UN POWDER. Ikawa, Katsuichi; Taketani, Kiyoaki (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol (Tokyo); 7: 433-8 (Sep 1970).

Fresh UN powder of a medium particle size (0.3 m²/g) prepared by nitridation of U powder was exposed to O_2 at room temperature in a constant volume apparatus. Oxidation was followed by pressure measurement. Under O_2 pressures higher than 3 mmHg the powder ignited instantaneously, probably due to local heating in the surface layers of the powder particles. When the O_2 pressure was lower, oxidation proceeded in two clearly distinct stages, without N_2 release. The first stage terminated instantaneously. Irrespective of differences in powder conditions and pressure, the amount of O_2 absorbed in the first stage was found almost invariably to be about 1.7 cm³ STP/m², which corresponds to the formation of an oxidized layer somewhat thicker than 18Å. The powder particles covered with this layer did not ignite even under 1 atm O_2. This oxide coating could be of practical utility for protection against ignition. The second stage proceeded very slow and could be completely suppressed by cooling. (auth)

Preparation and Fabrication

Refer also to abstracts 48149, 48804, 50109, 50111, 50113, 50114, and 50118.

48870 (BAW-3714-18) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 16, May–July 1970. Carlson, R. V. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Sep 1970. Contract AT(30-1)-3714. 24p. Dep. CFSTI.

Research directed toward development of a sol-gel process and related processes for preparing (U, Pu)O_2 fast reactor fuels is reported. Seven pellet, seven vipac, and seven sphere-pac pins containing $^{235}UO_2$-20% PuO_2 have been prepared for the unencapsulated bundle to be irradiated in the EBR-II. These are sufficient for the initial loading. All the pins have been Xe-tagged and welded, and the final inspection is in progress. The final five capsules scheduled in the "time-for-restructuring" series were irradiated in the BAWTR. Four capsules were irradiated simultaneously for 30 days, one each at 6, 10, 15, and 20 kW/ft. Another capsule was irradiated for 8 hours at 20 kW/ft. Nine of the BAWTR capsules have been disassembled in the BSW hot cell facility. No abnormalities were observed in the visual examination or gamma scans of the 27 pins contained in the nine capsules. (auth)

48871 (CONF-690954–, pp 192-219) METALLOGRAPHY OF SOME URANIUM–PLUTONIUM FUEL MATERIALS. Snider, R. H.; Mouser, W. R. (Battelle Memorial Inst., Columbus, Ohio).

From Technical papers of the 23rd metallographic group meeting held September 11–12, 1969, San Francisco, California.

Techniques for mounting and surface preparation of uranium–plutonium nitrides, uranium–plutonium dioxides and plutonium dioxide cermets are described. Metallography of these materials was conducted in glove boxes containing a nitrogen inert atmosphere. Microstructures of the various material compositions are evaluated in respect to methods for grinding and polishing and subsequent etching treatments. The effects of different etching solutions on microstructure and phase delineation are discussed. Methods to bring out the PuO_2 and metal matrix structures simultaneously are described for critical evaluation of the cermet materials. The results of various preparation techniques are supported by numerous photomicrographs. (auth)

48872 (DP-Report-361) STUDY OF THE DEPOSITION AND PROPERTIES OF PYROLYTIC COATINGS AND FUEL PARTICLE. Project DRAGON. Lanaspeze, P.; Tannenberger, H. (Atomic Energy Establishment, Winfrith (England)). Jul 1965. 55p. Dep. CFSTI (U. S. Sales Only).

Development of a method for coating Dragon fuel particles is described. Deposition of pyrocarbon was investigated. It was found that if deposition variables are controlled well, the pyrocarbon structure and layer thickness can be controlled. (J.R.D.)

48873 (DP-Report-369) DEVELOPMENT OF AN OVERCOATING PROCESS FOR FUEL CARTRIDGE MANUFACTURE. Project DRAGON. Redding, G. B.; Lamb, D. N.; Graham, L. W. (Atomic Energy Establishment, Winfrith (England)). Aug 1965. 18p. Dep. CFSTI (U. S. Sales Only).

Following an examination of methods established by the Project for the manufacture of coated particle-containing fuel bodies, work has been carried out on the application of an overcoating process to improve various features of consolidation. It has been shown that overcoating the coated fuel particles with matrix material prior to pressing is practicable on a production scale, and the ground rules for final optimization have been established. Apart from the predictable effects of overcoating the particles prior to pressing, namely the elimination of mixing problems, the cushioning effect of the overcoat which should minimize particle damage, and the regular dispersion of the fuel, it has been found that matrix density and isotropy are both improved. To obtain an improved pressing technique and to allow further development to a fully automated process work has also been carried out on a twin die system incorporating warm pressing and ejection. (auth)

48874 (NP-18353) TOKAI WORKS SEMIANNUAL PROGRESS REPORT, JULY–DECEMBER 1969. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Apr 1970. 108p. (N-831-70-1). Dep. CFSTI.

Activities directed toward development of mixed U and Pu oxide fuels for advanced fast breeder reactors and advanced thermal reactors are summarized. Work devoted to spent fuel reprocessing technology development and related research work is also reported. (J.R.D.)

48875 PROBLEMS ARISING FROM THE EMPLOYMENT OF A METAL IMPREGNATED GRAPHITE AS A CLADDING MATERIAL OF FUEL ELEMENTS. Lanza, F.; Marongo, G. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan); 17: 481-8(Aug 1970). (In Italian).

A composite material has been obtained by impregnating graphite with metals. The possibility is discussed of using such material as fuel element cladding. The characteristics of impermeability of this material are illustrated and some junction methods are de-

scribed. A new fuel element is proposed, which can be produced by the same impregnation process necessary to obtain the cladding composite material itself. (auth)

48876 URANIUM/NITROGEN COMPOUNDS. (to Mitsubishi Kinzoku Kogyo Kabushiki Kaisha). British Patent 1,204,380. 9 Sep 1970. Priority date 6 Oct 1966, Japan.

A process for producing uranium nitrides and/or uranium carbonitrides for reactor fuels consists of introducing a uranium carbide starting material and dehydrated NH_3 into a decarbonization reaction vessel and heating the starting material to a temperature of 300 to 900°C. The uranium carbide starting material and NH_3 are allowed to react, and all or part of the C in the starting material is removed as a hydrocarbon gas and a high order [U:N or U:(N,C) ratio > 1] UN or UCN is formed. (B.L.M.)

48877 HIGH TEMPERATURE OXIDES. PART II. OXIDES OF RARE EARTH, TITANIUM, ZIRCONIUM, HAFNIUM, NIOBIUM, AND TANTALUM. Alper, Allen M. (ed.). Refractory Materials, a Series of Monographs. Volume 5. New York; Academic Press Inc. (1970). 288p. $16.50.

Information in the volume is presented in seven chapters. A separate abstract was prepared for each of six chapters. One chapter on titanates and zirconates was not in scope for NSA. (J.R.D.)

For abstracts of individual chapters see: 48878, 48894–48896, 48903, and 48904.

48878 HAFNIUM OXIDE. Lynch, C. T. (Wright-Patterson Materials Lab., Wright-Patterson AFB, Ohio). pp 193-216 of High Temperature Oxides. Part II. /Alper, Allen M. (ed.). New York; Academic Press Inc. (1970).

Information is reviewed on Hf occurrence, purification, physical properties, crystal structure, phase relations, Hf–O systems, thermodynamic properties, engineering properties, infrared spectra of HfO_2, preparation of HfO_2, and properties of HfO_2 coatings. (J R.D.)

48879 MIXED CERAMIC MATERIALS BASED ON MOLYBDENUM WITH OXIDE SPINEL BONDS. Rasch, H.; Lehmann, H.; Koltermann, M. Ber. Deut. Keram. Ges.; 47: 465-70(Aug 1970). (In German).

Other conditions being equal spinel-bonded cermets attain a better degree of sintering than those based on the use of calcined alumina. Likewise pure spinel materials fired in hydrogen attain a higher degree of sintering than do corundum specimens. Partial replacement of magnesium aluminate by oxides and spinels of Mn, Ni, Co, and Cr increases both the strength and the amount of fine grains in Mo-spinel cermets. Additions of these above metals also promote the densification of molybdenum powders during the firing. Results of x-ray investigations on possible boundary surface reactions indicate a slight lattice deformation due to a penetration into it of Mo ions by diffusion. Mn ions penetrate into the lattice to form a mixed spinel (Mn, Mg)Al_2O_4. When added to a Mo powder, metallic Ni and Co neither react appreciably with alumina, nor spinel (when in contact with these). Spinels that had been made in this way dissociate in a H_2 atmosphere into metal and corundum. The best material properties of spinel-Mo cermets are attained by adding small amounts of metallic Mn and Mn spinel. (auth)

48880 CONTRIBUTION TO THE STUDY OF THE CHARACTERISTICS OF FRITTABLE URANIUM OXIDES. I. Constantinescu, Florica; Galatchi, Gheorghe; Tosocan, Mariana. Rev. Roum. Phys.; 15: 715-16(1970). (In French).

Studies were made on the oxidability of uranium oxide powders as a function of the calcination temperature of ammonium diuranate and the specific surface. Reduction took place at 700°C in hydrogen. The conversion ratio for UO_2/U_3O_8 was calculated. It was found that the oxidability was greater in the case of calcined powders at low temperature and high specific surface. However, it was also noticed that under the same experimental conditions, the values for the ratio of transformation O:U decreased more quickly with increase in temperature of preparation than the values of the specific surface. (P.C.H.)

48881 IMPROVEMENTS IN DEPOSITION OF PYROLYTIC GRAPHITE. (to General Electric Co.). British Patent 1,206,118. 23 Sep 1970. Priority date 3 Oct 1966, United States.

Methods and equipment for preparation of articles by gas pyrolysis is described. Carbonaceous gas is pyrolytically deposited on substrates in the desired shape. After the graphite is deposited the mandrel assembly is removed from the article. (J.R.D.)

48882 PROCESS FOR THE FABRICATION OF NUCLEAR FUEL ELEMENTS. Moreau, Claude (to Commissariat a l'Energie Atomique). British Patent 1,206,559. 23 Sep 1970. Priority date 23 Sep 1968, France.

A method of fabricating fuel elements consisting of a central core of refractory oxides, carbides, or nitrides of U or Pu is described. The refractory particles are dispersed in a carbonaceous matrix and are coated with graphite. The graphite coating is deposited on the particles by spraying followed by baking at 850 to 1100°C. (J.R.D.)

48883 METHOD OF MANUFACTURING SINTERED ARTICLES FROM METAL OXIDES. Boulinier, Claude; Meunier, Jean; Remy, Andre (to Commissariat a l'Energie Atomique). British Patent 1,207,107. 30 Sep 1970. Priority date 12 Mar 1968, France.

A method of fabricating sintered shapes from a ternary oxide mixture is described. The sintered shapes contain the phase Fe_2O_3–Cr_2O_3 and the complex, ferrite phase $FeCrNiO_4$. The shapes are produced by mixing the desired portions of Fe_2O_3, Cr_2O_3, and NiO and heating at 900 to 1200°C. (J.R.D.)

48884 PARTICULATE NUCLEAR FUELS. (to Gulf General Atomic Inc.). British Patent 1,206,927. 30 Sep 1970. Priority date 25 Apr 1967, United States.

A method of producing fuel particles incorporating fuel and fertile materials in different layers is described. The layered particles are coated with fission product-retaining materials. The coatings contain either ZrC or NbC with pyrocarbon matrix. (J.R.D.)

Properties Evaluations

Refer also to abstracts 48818, 48826, 48828, 48831, and 48832.

48885 (CONF-690954–, pp 130-46) CHARACTERIZATION OF SOME $Cr_{23}C_6$-MODIFIED (U,Pu)C FUELS FOR IRRADIATION TESTING. French, P. M.; Hodge, M. H.; Jacoby, W. R.; Shalek, P. D. (Westinghouse Electric Corp., Cheswick, Pa. Advanced Reactors Div.).

From Technical papers of the 23rd metallographic group meeting held September 11–12, 1969, San Francisco, California.

Additions of modifying materials to nonstoichiometric (U,Pu)C have been proposed to improve the compatibility of these potential fast reactor fuels with stainless steel cladding. The modifying materials react with the secondary phases to form more refractory and less reactive secondary phase products during the sintering cycle of the fabrication of (U,Pu)C pellets. Such pellets have been fabricated for thermal and fast flux irradiation studies in which $Cr_{23}C_6$ has been added as the modifier to hypostoichiometric (U,Pu)C powder. The best structure of these pellets should be a matrix of (U,Pu)C, with secondary phases of Cr + $Cr_{23}C_6$ occurring as a grain boundary network. Metallographic, chemical, and electron microprobe techniques have been used to determine the composition of the phases which occurred in $Cr_{23}C_6$-modified (U,Pu)C fuel pellets. The pseudo ternary (U,Pu)–Cr–C phase diagram has been constructed by extrapolation from the U–Cr–C diagram and the pellet compositions obtained have been located on this. The various characterization techniques that have been employed are reviewed and details of how the data from each is related and used to predict pellet composition are discussed. (auth)

48886 (COO-1436-28) TRANSPORT AND THERMODYNAMIC PROPERTIES OF SOLIDS. Technical Progress Report, September 1, 1969–August 31, 1970. Grace, Richard E. (Purdue Univ., Lafayette, Ind. School of Materials Science and Metallurgical Engineering). 1 Sep 1970. Contract AT(11-1)-1436. 28p. Dep. CFSTI.

Research directed to kinetics of ternary diffusion in Ag–Zn–Cd and in Cu–Zn–Ni is summarized. Research on electrical properties and diffusion of point defects in calcium tungstate ($CaWO_4$); and diffusion-limited sulfidation reactions in the Fe–O–S and Mn–O–S systems is also reported. (J.R.D.)

48887 (DP-MS-70-10) INTERACTION OF CURIUM SESQUIOXIDE WITH REFRACTORY METAL MATRICES IN PRESSED AND SINTERED CERMET COMPACTS. Donovan, J. A.; Rankin, D. T.; Stuckey, J. E.; McDonell, W. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 1 Jun 1970. Contract AT(07-2)-1. 24p. (CONF-700608-21). Dep. CFSTI.

From American Nuclear Society Meeting, Los Angeles, Calif.

No reaction was observed between B-type $^{244}Cm_2O_3$ and tungsten, molybdenum, or rhenium matrices in cermet compacts fabricated by cold pressing and sintering at temperatures up to 1850°C. Reaction was observed, however, between the oxide and tantalum matrices sintered as low as 1400°C. Cold pressing and sintering at the highest temperatures produced generally well-consolidated Cm_2O_3-refractory metal compacts of 85% or greater

theoretical density. In compacts produced from well-mixed powders, the oxide was distributed uniformly in the metal matrix with little vaporization loss of Cm_2O_3. (auth)

48888 (DP-Report-375) STUDIES ON COATED PARTICLE FUEL. Final Report of Work Carried Out at C.E.N., Saclay for the Dragon Project. Fally, J. (Atomic Energy Establishment, Winfrith (England)). Sep 1965. 7p. Dep. CFSTI (U. S. Sales Only).

As a result of thermal expansion studies carried out on thorium dicarbide an anomaly has been brought to light which may be expressed as a rapid dimensional change between 1220 and 1265°C. This has been interpreted as a phase transformation in that range of temperature. The nature of the reaction layer which is found, after prolonged heat treatment of Dragon fuel particles, between the core and the pyrocarbon coating of the particles was determined as graphitization of the pyrocarbon in the coating. It appears that in the case of the batches which were studied, the speed of the reaction is apparently independent of the nature of the pyrocarbon. It also appears that at 1600°C most of the coatings become graphitized over a period of 1,000 to 2,000 hr. The shape of the curves describing the kinetics of the phenomenon shows that diffusion alone cannot explain the evolution which has been noted. Work has been carried out to correlate the characteristics of the pyrocarbon deposit and the results of alpha counting after heat treatment, which indicates the amount of surface contaminstion of the particles with uranium and thorium. These results show that the coating of the particles should have a thickness of at least 60 micron and that the coating density should be more than 1.8 g/cm^3 in order that the alpha count can be kept relatively low. (auth)

48889 NEW FUELS FOR FAST REACTORS. Cordfunke, E. H. P. Atoomenergie Haar Toepass.; 11: 263-71(Nov 1969). (In Dutch).

Fast reactors require fuel with greater U concentration and heat conductivity than can be obtained by using UO_2. The fuel characteristics of semimetallic compounds by U and Pu with C, N, or S which form cubic crystals are indicated in tables and graphs, mentioning also the potential usefulness of carbides (UC, U_2C_3, and UC_2), nitrides (UN, U_2N_3, and UN_2) and sulfides (primarily US) as fuel material. The properties and synthesis of solid solutions with mixed ions, e.g., (U, Pu)N and (U,Pu)(N,C) are discussed. Nitrogen stabilizes the structure and reduces the probability of the formation of higher carbides (UC_2, Pu_2C_3). The solid solutions may be prepared using UO_2. The effect of radiation on the carbonitrides and thermodynamic properties of these materials are still insufficiently known. (TTT)

48890 STUDY ON THE ORIGIN OF HYDROGEN GAS RELEASED FROM UO_2 BY TRACER TECHNIQUE USING HEAVY WATER. Hoshino, Akira; Matsuda, Yuji; Ouchi, Misao; Komori, Takuji. Nippon Genshiryoku Gakkaishi; 12: 500-4(Sep 1970). (In Japanese).

A study by mass spectrometry was performed with the view to ascertaining the origin of hydrogen gas emanating from UO_2. The deuterium content in the hydrogen gas released from UO_2 powder under a vacuum of 10^{-5} mmHg after treating with heavy water, increases with the extraction temperature and reaches about 40 at. % at 1,700°C. When the sample was treated with heavy water and then heated under the same vacuum condition at 400°C, the deuterium content in the hydrogen gas released under the same vacuum condition above 1,000°C is nearly equal to that of natural hydrogen, and the amount of total hydrogen is very small in comparison with the case of untreated sample. From these experimental results, it is concluded that most of the hydrogen gas released from UO_2 at high temperatures (>1,000°C) probably results from the decomposition of water contained in the sample. (auth)

48891 RESEARCH ON THE INTERACTION MECHANISM OF MoO_3 AND WO_3 WITH CARBON. Pavlov, Yu. A.; Sheboldaev, S. B.; Meshcheryakov, G. Ya.; Polyakov, V. P. Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 4, 26-30(Apr 1970). (In Russian).

Reactions of MoO_3 and WO_3 with graphite were studied during the spatial distribution of reagents by x-ray, phase, and micro-x-ray spectral analyses. The mechanism of the oxide reactions with carbon stressed the importance of the diffusion processes developing in the oxide phase. (tr-auth) (INIS)

48892 PROBLEMS AND EXPERIENCES ON THE APPLICATION OF SOLID ELECTROLYTES IN GALVANIC CELLS. Middendorf, H.-W.; Poetschke, J.; Frohberg, U. M. G. (Technische Univ., Berlin). Metall; 24: 617-24(Jun 1970). (In German).

For measurement of thermodynamic and kinetic parameters, attempts were made to utilize heterogeneously mixed oxides of solid electrolytes that conduct oxygen ions. Experimental studies were performed with CaO-stabilized zirconium dioxide to measure oxygen potential in melted copper. (H.B.G.)

48893 OBSERVATION OF THE FRACTURE PATH IN WC–Co CEMENTED CARBIDES USING A NEWLY DEVELOPED REPLICA METHOD WITH AN ELECTRON MICROSCOPE. Hara, A.; Nishikawa, T.; Yasu, S. (Sumitomo Electric Industries Ltd., Itami, Japan). Planseeber. Pulvermet.; 18: No. 1, 28-43(Mar 1970).

A new replica method was developed, using an electron microscope for observing the fracture path in WC–Co cemented carbides. By this method a comparison could be made of the same part of the fracture surface in both the fractured state and the Co-dissolved state (using selective etching for the latter). In fine WC–CO cemented carbides, no WC grain fracture was observed. In coarse WC-Co cemented carbides, the ratio of fracture in the WC grain and the WC-WC interface was smaller than hitherto reported. (auth)

48894 THORIA AND YTTRIA. Anderson, Richard C. (General Electric Co., Schenectady, N. Y.). pp 1-40 of High Temperature Oxides. Part II. /Alper, Allen M. (ed.). New York; Academic Press Inc. (1970).

Information on structural, chemical, electric, mechanical, optical, and nuclear properties is summarized. Information is also included on preparation and applications. (J.R.D.)

48895 REFRACTORY OXIDES OF THE LANTHANIDE AND ACTINIDE ELEMENTS. Eyring, LeRoy (Arizona State Univ., Tempe). pp 41-97 of High Temperature Oxides. Part II. /Alper, Allen M. (ed.). New York; Academic Press Inc. (1970).

Information on lanthanide oxides is presented which includes physical and other properties, thermochemical aspects, oxygen transport, and crystal growth. Similar information is included on actinide oxides through californium. (J.R.D.)

48896 ZIRCON AND ZIRCONATES. Baldwin, William J. (National Lead Co., Niagara Falls, N. Y.). pp 167-92 of High Temperature Oxides. Part II. /Alper, Allen M. (ed.). New York; Academic Press Inc. (1970).

Information is presented on occurrence and beneficiation, properties, and uses of zircon. Information is also presented on alkali zirconates, alkaline earth zirconates, lead zirconates, rare earth zirconates, and zirconium oxide–uranium dioxide solid solutions. (J.R.D.)

48897 FRICTIONAL FORCE COEFFICIENT OF A MOVING DISLOCATION IN URANIUM DIOXIDE WITH EXCESS OXYGEN. Igata, N.; Domoto, K.; Hasiguti, R. R. (Tokyo Univ.). J. Phys. Chem. Solids; 31: 1883-8(Aug 1970).

The frictional force coefficient B of moving dislocations in uranium dioxide with excess oxygen in the UO_2 to U_4O_9 range was measured at temperatures from −40 to +200°C by means of ultrasonic attenuation. The B values increase in the two temperature regions of relaxational internal friction peaks. These increases of B values are interpreted in terms of the redistribution of atoms, which brings forth the phase change, and the Snoek ordering of excess interstitial oxygen atoms, respectively, in the stress field of the moving dislocations. (auth) (UK)

48898 PROPERTIES OF TITANIUM–TUNGSTEN–SILICON SYSTEMS. Maksimov, V. A.; Shamrai, F. I. (Inst. of Metallurgy, Moscow). Metalloved. Term. Obrab. Metal.; No. 2, 69-70(1970). (In Russian).

The introduction of W and Si in an alpha-solid solution of Ti increased the strength by 10 to 20 kg/mm^2 and retained the high plasticity. A metastable α' phase was formed during quench hardening of alloys from beta-solid solutions. The stability of alloys containing up to 4.8% W increased significantly and reached 93 kg/mm^2. Alloys tempered from the two-phase α plus β phase had less stability than when tempered from the β phase. However, the plasticity was higher. (tr-auth)

Structure and Phase Studies

Refer also to abstract 48849.

48899 ON THE CRYSTALLINE STRUCTURE OF UO_2Cl_2, $2[(C_5H_{12}NHCl]$. Brusset, Henry; Nguyen Quy Dao; Haffner, Francois (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France. Paris Univ.). Bull. Soc. Chim. Fr.; No. 5, 1759-60(May 1970). (In French).

The compound crystallizes in the quadratic system with the following parameters a = b = 13.50 ± 0.05 Å and c = 24.32 ± 0.05 Å; it belongs to the $I4_1/a$ space group with eight molecules in the unit cell. (auth) (France)

48900 CERIUM–COBALT–SILICON SYSTEM. Bodak, O. I.; Gladyshevskii, E. I. (Lvov State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater.: 6: 1186-9(Jun 1970). (In Russian).

The phase equilibrium and crystal structure of compounds of the Ce–Co–Si system were studied and compared with published data on Ce–Ni–Si and Ce–Fe–Si systems. The results show that the number of compounds formed in the Ce–Co–Si system occupies the intermediate position between the previously studied Ce–Ni–Si and Ce–Fe–Si systems. (tr-auth)

48901 STRUCTURE AND CERTAIN PROPERTIES OF YTTRIUM DIBORIDE. Manelis, R. M.; Telyukova, T. M.; Grishina, L. P. Izv. Akad. Nauk SSSR, Neorg. Mater.: 6: 1184-5(Jun 1970). (In Russian).

The structure and thermoemission properties of yttrium diboride were studied at temperatures from 1500 to 2000°K. The density of emission current was measured under static conditions at 1500°K and under pulsed conditions at temperatures from 1600 to 2000°K. Tabulated results are included. (tr-auth)

48902 FORMATION OF SUBOXIDE Nb_2O IN NIOBIUM–OXYGEN SYSTEM. Dekanenko, V. M.; Kornilov, I. I.; Glazova, V. V. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.: 6: 1110-13(Jun 1970). (In Russian).

After prolonged, step-by-step annealing of cast alloys containing more than 4 at. % of oxygen, the following phases were revealed: niobium solid solution and the lower oxide of niobium oxide. (tr-auth)

48903 ZIRCONIUM DIOXIDE AND SOME OF ITS BINARY SYSTEMS. Garvie, R. C. (Corning Glass Works, N. Y.). pp 117-66 of High Temperature Oxides. Part II. /Alper, Allen M. (ed.). New York; Academic Press Inc. (1970).

Information is presented on the structure of polymorphs in ZrO_2. Information is also included on phases in $MgO–ZrO_2$ systems, phase equilibria in $CaO–ZrO_2$ systems, and on partially stabilized ZrO_2 ceramics. (J.R.D.)

48904 Nb_2O_5 AND Ta_2O_5 STRUCTURE AND PHYSICAL PROPERTIES. Reisman, A.; Holtzberg, F. (IBM Watson Research Center, Yorktown Heights, N. Y.). pp 217-57 of High Temperature Oxides. Part II. /Alper, Allen M. (ed.). New York; Academic Press Inc. (1970).

Work directed toward understanding polymorphism in Nb_2O_5 and Ta_2O_5 is reviewed. X-ray data are summarized and interpreted, and information on nonstoichiometry in these compounds is analyzed along with thermodynamic data. (J.R.D.)

48905 FORMATION OF SHEAR STRUCTURES IN SUBSTOICHIOMETRIC TUNGSTEN TRIOXIDE. Tilley, R. J. D. (Univ. of Bradford, Eng.). Mater. Res. Bull.: 5: 813-24(Sep 1970).

Single crystals of tungsten trioxide prepared by sublimation were reduced in vacuo at temperatures up to 850°C. They were studied by electron microscopy, optical microscopy, and x-ray powder diffraction. The microstructure of these crystals consisted predominantly of planar defects on {120} planes. The number of these defects increased with the degree of reduction and they were partly ordered in some samples. Evidence to support the hypothesis that they are crystallographic shear planes is presented, and its bearing on the accommodation of nonstoichiometry in the WO_3 lattice by way of shear planes is discussed. (auth)

48906 CRYSTALLITE SIZE OF PYROLYTIC GRAPHITE. Morant, R. A. (Univ. of Durham, Eng.). J. Phys., D (London): 3: 1367-73(Sep 1970).

X-ray line broadening techniques were used to determine both a- and c-direction crystallite sizes for a range of pyrolytic graphite samples whose effective formation temperature lay between 2330 and 3020°C. X-ray line profiles were analysed using the variance method. It is shown that if the proper allowance is made for the stacking fault contribution to the 110 line, the x-ray determination gives results for the a-direction crystallite size in good agreement with estimates obtained from the mobility and thermal conductivity of the samples. The a-direction crystallite sizes ranged from 0.01 to 3 μm and gave a thermal activation energy of 5.9 eV for a-direction crystallite growth. The crystallite size ratio L_a/L_c increased linearly with formation temperature in the range 2500 to 3020°C, reaching a value of 36 at 3020°C. (auth) (UK)

48907 SYSTEM NIOBIUM PENTOXIDE–PHOSPHORUS PENTOXIDE. Levin, Ernest M.; Roth, Robert S. (National Bureau of Standards, Washington, D. C.). J. Solid State Chem.; 2: 250-61(Aug 1970).

A partial phase diagram of the system $Nb_2O_5–P_2O_5$ was determined experimentally, using the quenching technique and identifying the phases by x-ray powder diffractometry. The major phase, $NbPO_5$, had a melting point above 1650°C. It transformed at about 1253°C from a low-temperature, tetragonal phase to a high-temperature, monoclinic phase, isostructural with $TaPO_5$. The $9Nb_2O_5 \cdot P_2O_5$ phase showed a limited solid solution range and melted incongruently at 1435°C. The eutectic between 9:1 and $NbPO_5$ was at 1365°C and 67 mole % Nb_2O_5. At 96.4 mole % Nb_2O_5 another phase was found, stable between ~1340 and 1420°C and isostructural with the 9:1 phase. A new monoclinic phase, 22:1 ss was found, with a limited stability field in both temperature and composition. It is most likely composed of 3 × 3 and 3 × 4 ReO_3-type blocks of octahedrally oxygen-coordinated niobium. In the subsystem $NbPO_5–P_2O_5$ liquidus values could not be determined even in sealed Pt tubes because of reactivity and high vapor pressure of P_2O_5. One compound was identified of probable composition $Nb_2O_5 \cdot 2P_2O_5$, with pseudocubic symmetry and melting incongruently at about 1025°C. X-ray powder diffraction data and unit cell dimensions are listed for the phases. (auth)

48908 EVIDENCE FOR AND STUDY OF THE ORDERED PHASE $Y_2Hf_7O_{17}$ IN THE SYSTEM $HfO_2–Y_2O_3$. Duclot, Michel; Vicat, Jean; Deportes, Charles (LERCEM, Grenoble, France). J. Solid State Chem.; 2: 236-49(Aug 1970). (In French).

The $HfO_2–Y_2O_3$ system showed an ordered phase, compared with the metastable fluorite-type phase, corresponding to the finite compound $Y_2Hf_7O_{17}$. The transformation order — disorder was studied by different methods. The phase diagram of the system $HfO_2–Y_2O_3$ in the part rich in hafnium dioxide was drawn. (auth)

Radiation Effects

Refer also to abstracts 48863, 49973, 50110, 50114, and 50115.

48909 (AECL-3606) IRRADIATION PERFORMANCE OF ZIRCALOY SHEATHED FUEL ELEMENTS WITH METALLIC OR CERAMIC DISCS BETWEEN UO_2 PELLETS. MacDonald, R. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug 1970. 53p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

Zircaloy-clad fuel elements were irradiated with thin disks of refractory metals and oxides between UO_2 pellets to study the effect of disks in lowering the bulk average temperature of the fuel. Disk materials included tungsten, molybdenum, rhenium, tantalum, niobium, Al_2O_3, ThO_2 and graphite. The experiment showed that the refractory metal disks between pellets did reduce the grain growth volume in the adjacent UO_2 as well as preventing gross redistribution of fuel in elements operating at linear heat outputs >900 W/cm. Disks of refractory metals 1.3 mm thick were all compatible with the fuel while 3.3 mm thick disks of Al_2O_3 and ThO_2 reacted with the UO_2. Graphite disks, 1.0 mm thick, were compatible with UO_2 at linear heat outputs of 650 W/cm. Disks between pellets did not seem to improve the dimensional stability of the fuel elements. Four of the nine elements in the test defected in-reactor probably because of the low ductility of the Zircaloy sheaths after irradiation. The metal disks apparently provided the localized sheath strain needed to rupture these low ductility sheaths. (auth)

48910 ELASTIC CONSTANTS AND ELECTRON-MICROSCOPE OBSERVATIONS OF NEUTRON-IRRADIATED COMPRESSION-ANNEALED PYROLYTIC AND SINGLE-CRYSTAL GRAPHITE. Seldin, E. J.; Nezbeda, C. W. (Parma Tech. Center, Ohio). J. Appl. Phys.; 41: 3389-3400(Jul 1970).

Compression-annealed pyrolytic graphite and single-crystal graphite specimens were irradiated with neutrons for total exposures of 3 to 71×10^{17} neutrons/cm² (nvt) at 50°C, 3 to 8×10^{19} nvt at 650°C, and 1.2×10^{20} nvt at 1000°C. The elastic constants of the materials were determined before and after irradiation by ultrasonic-, sonic-resonance-, and static-test methods. The only elastic constant that changed significantly with irradiation was the shear modulus c_{44} although a small change was also seen in c_{33}. The natural crystals after irradiation had shear moduli in the range of 0.16 to 0.46×10^{11} dyne/cm², the modulus after irradiation showing no correlation with irradiation temperature, exposure, or modulus before irradiation. The average values of the shear modulus of the pyrolytic graphite were 0.22 to 0.40×10^{11} dyne/cm² after irradiation at 50°C, 0.030 to 0.033×10^{11} dyne/cm² after irradiation at 650°C, and 0.042×10^{11} dyne/cm² after irradiation at 1000°C; the modulus at the irradiation temperatures of 50 and 650°C increased as the neutron exposure increased. The

shear modulus c_{44} of graphite when all dislocations are pinned is thus equal to greater than 0.40×10^{11} dyne/cm^2. The results can be correlated with electron-microscope observations and interpreted in terms of nucleation theory of radiation damage or in terms of a difference in the availability of sinks for the displaced atoms. (auth)

Plastics and Other Materials

Refer also to abstract 49246.

48911 (ANL-7693) COMPUTER PROGRAM FOR THE KINETIC TREATMENT OF RADIATION-INDUCED SIMULTANEOUS CHEMICAL REACTIONS: A REVISED VERSION IN FORTRAN IV. Schmidt, Klaus H. (Argonne National Lab., Ill.). Mar 1970. Contract W-31-109-eng-38. 56p. Dep. CFSTI.

WR20, a program written in OS/360 FORTRAN IV for an IBM-360/75 digital-computer system, calculates, as a function of time, the concentrations of all chemical species in a set of radioinduced chemical reactions with homogeneous kinetics. It also calculates the concomitant changes in electrical conductivity and optical absorbance. As data, the program essentially requires the chemical reaction equations with rate constants, a list of the chemical species with their radiation yields, initial concentrations; equivalent conductances, absorptivities, etc., and the dose rate as a function of time. The program is an improved version of one described in an earlier report (ANL-7199, April 1966) written for a CDC-3600 system. The new features of the revised program, in particular, the possibility to treat reaction systems involving chain reactions and to study the effect of repetitive radiation pulses, are described, and detailed instructions are given for the use of the program. Two plotting programs to be used in connection with WR20 are also described. One creates a plot on a 780-Calcomp plotter, the other a plot on the printer. (auth)

48912 EFFECT OF RADIATION UPON THE STRENGTH OF GLASS PLASTICS. Fefelov, P. A. This paper was summarized in At. Energ. (USSR); 25: 318-19(Oct 1968) as paper No. 238. (In Russian).

Studies were made on the effects of electron irradiation upon the strength properties of the anisotropic fiberglass material SVAM, which is used in the production of mechanically supporting vacuum casings. The effects were assessed by the change in the static bending strength of 2 mm thick samples. The strength of the material SVAM-1 was found to be strongly dose dependent. First, the strength increased (up to doses of about 10^9 R); afterwards, the strength decreased by as much as 25% from the maximum value in the dose interval from 10^9 to 10^{10} R. In comparison with SVAM-1 material, the SVAM-2 samples were irradiated with doses ranging from 5×10^8 to 5×10^9 R. This material preserved superior strength even after irradiation. (P.C.H.)

48913 EFFECT OF γ-RAY IRRADIATION ON THE FINE STRUCTURE AND VISCOELASTIC PROPERTIES OF HIGH-IMPACT ABS RESIN. Nagou, Satoshi (Tokuyama Soda Co. Ltd., Yamaguchi, Japan). Kogyo Kagaku Zasshi; 73: 1551-7 (Jul 1970). (In Japanese).

The effects of γ irradiation on the fine structure and viscoelastic properties on high impact ABS resin were investigated. The results of the measurements of dynamic viscoelastic properties and mechanical properties, and the electron microscopic examination of ABS resin irradiated by γ-rays to various total dose were examined-while paying special attention to crazing (zone of molecular orientation) and comparing with those of unirradiated specimen. When crosslinks were introduced by γ-ray irradiation, a total dose higher than about 100 Mrad was not favorable as the specimen became brittle. However, when a total dose was lower than this value, the occurrence of crazing was prevented, and better mechanical properties resulted. (auth) (Japan)

48914 COMPOSITION AND METHOD FOR SHIELDING COMPONENTS FROM NEUTRON IRRADIATION. Ronzio, Anthony Rose (to Mobco Oil Corp.). British Patent 1,264,431. 9 Sep 1970. Filed 24 Jah 1968.

A shielding material is described that is both a neutron moderator and a neutron absorber. It comprises a solid solution of an anhydrous salt of naphthenic or 2-ethylhexanoic acid and a metal such as Cd, Gd or Sm in a wax. This composition can be moulded around delicate instruments. The method of making and using the composition is also described. (UK)

48915 INITIATION OF EXPLOSIVES BY HIGH-ENERGY ELECTRONS. Phung, P. V. (Lockheed Palo Alto Research Lab., Calif.). J. Chem. Phys.; 53: 2906-13(1 Oct 1970).

With very short and very intense pulses of fast electrons such as from a Febetron machine, many explosives can be initiated at doses clearly insufficient for uniform heating to initiation temperature. This provides an opportunity for further testing of the hot-spot theory on initiation of explosives. In this study, a stochastic model is presented to describe the nonuniform spatial distribution of energy packets arising from absorption of electrons or photons. Computer calculations using an appropriate heat conduction equation determine what average temperature (or dose) and corresponding hot-spot temperature are required for initiation. Critical doses calculated for PbN_6, PETN, RDX, HMX, and nitroglycerine are 37.8, 21.4, 38.5, 37.3, and 21.6 cal/g, respectively. Experimental doses for dextrinated PbN_6, BaN_6, basic lead styphnate, and normal lead styphnate, are estimated from limited experimental data as 11, 19, 18, and 10 cal/g, respectively. Factors responsible for differences between calculated and observed values are indicated. The correct order of magnitude of the calculated results is considered as evidence supporting the thermal mechanism in initiation of explosives by high-energy radiations. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 48052.

48916 ELECTRODYNAMIC LINE BROADENING TOGETHER WITH THE LINEAR STARK EFFECT. Galushkin, Yu. I. Sov. Astron. AJ (Engl. Transl.); 14: 301-7(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 375-83(Mar-Apr 1970).

The broadening of hydrogen lines is considered for the case where the Doppler, Zeeman, and electrodynamic [due to the field 1/c(VH)] broadening mechanisms are present simultaneously. Beyond the half width the line profile is closely approximated by a superposition of Doppler profiles. With Zeeman splitting neglected, the profiles of the Hα and Hβ lines are calculated for the conditions prevailing in the Tokomak 3 thermonuclear facility ($N_e = 10^{12}$ to 10^{13} cm^{-3}, $T_i = 0.5$ keV, $H = 3 \times 10^4$ gauss). At the point $\Delta\omega = 3\omega_H$ the relative intensity of the Hβ line when the electrodynamic effect is included is an order of magnitude greater than the value for the pure Doppler case. The case of line broadening involving the quadratic Stark effect is discussed briefly. (auth)

Cosmic Ray Exposure Ages

48917 I-Xe DATING: EVIDENCE FOR COLD ASSEMBLY OF AN UNEQUILIBRATED CHONDRITE. Podosek, F. A. (Univ. of California, Berkeley); Hohenberg, C. M. Earth Planet. Sci. Lett.; 8: 443-7(Jul 1970).

Essentially all of the more equilibrated meteorites which contain excess radiogenic ^{129}Xe have well-defined I–Xe formation intervals that apparently date the onset of proportional retention for iodine and radiogenic ^{129}Xe from the decay of ^{129}I. Precise data on the unequilibrated chondrite Manych, which contains large excesses of ^{129}Xe, clearly demonstrates a lack of correlation between the radiogenic ^{129}Xe and iodine. Although this effect might be accounted for by other mechanisms, it can also be interpreted as evidence for the cold accretion of constituent parts, some of which may have retained the I–Xe record of a previous history. Re-examination of data from the unequilibrated chondrites Chainpur and Renazzo tend to support such an interpretation. (auth)

48918 MASS FRACTIONATION AND ISOTOPE ANOMALIES IN NEON AND XENON. Kuroda, P. K.; Manuel, O. K. (Univ. of Arkansas, Fayetteville). Nature (London); 227: 1113-16 (12 Sep 1970).

The neon and xenon isotope anomalies observed in meteorites can be interpreted in terms of a mass fractionation, which is common for both elements. It is not necessary to assume the existence of large excesses of fission-type xenon in carbonaceous and gas-rich chondrites. (auth) (UK)

Stars

48919 (LA-4398-TR) ESCAPE OF STARS FROM ISOLATED CLUSTERS. Henon, M. Translated for Los Alamos Scientific Lab., N. Mex., from Ann. Astrophys.; 23: 668-77(1960). 6p. Dep. CFSTI.

It is shown that the escape of a star from an isolated cluster can occur only as the result of a close encounter that causes an abrupt increase in energy. The rate of escape is recalculated; the result found is about 100 times smaller than the classical value. Escape is negligible in globular clusters, and insufficient to cause the disappearance of galactic clusters. However, these results do not take into account the galactic field, and they should be reconsidered in this light. (auth)

48920 NONROTATING DENSE STARS. PART I. THEORY OF EQUILIBRIUM. Abramowicz, Marek Artur. Postepy Astron.; 18: 279-304(Sep 1970). (In Polish).

An introduction to the theory of equilibrium and stability of white dwarfs, neutron stars, and hyperon stars is presented. The theory of equilibrium of nonrotating objects, formed from a degenerate, cool (electron or neutron) gas, is considered. The importance of the theory in interpreting some observed objects is discussed. (auth)

48921 ABSORPTION COEFFICIENT OF H^- AND INTERPARTICLE INTERACTION. II. FORBIDDEN BOUND-FREE CONTINUUM. Tarafdar, S. P.; Vardya, M. S. (Tata Inst. of Fundamental Research, Bombay). Mon. Notic. Roy. Astron. Soc.; 150: 9-13(1970).

The forbidden bound–free continuum cross section of H^-, arising due to perturbation by the protons, was recalculated and found to be smaller by a factor of $\sim 10^5$ compared to that obtained earlier (1966). It is unlikely to be significant in stars of spectral type around G and later. (auth) (UK)

48922 SEARCH FOR MILLIMETRE WAVE EMISSION FROM BLUE STELLAR OBJECTS. Conklin, E. K. (National Radio Astronomy Observatory, Tucson, Ariz.). Nature (London); 227: 1119-20(12 Sep 1970).

According to Burbidge there are now 30 "radio-quiet" QSOs with measured redshifts, and these are here referred to as "blue stellar objects". The term "radio-quiet" means that they were identified optically, but not in any general survey of radio sources. A number of these BSOs have been examined by different observers for possible radio emission on wavelengths from 94 to 2cm, but nearly always with negative results. A new survey of BSOs at mm wavelengths was felt worthwhile, as it was thought that these objects might be detectable only at short wavelengths, and the observations described were made at 9.5 and 3.5 mm (31.5 and 85.3 GHz), in Dec. 1969 and Jan. 1970, using the 36-ft dish at Kitt Peak, Arizona. The data for the 16 sources observed are tabulated. Most of the BSOs have now been surveyed at wavelengths from 94 cm to 3.5 mm, with no detectable emission. A possibility which earlier observations did not exclude was that BSOs are compact and have a high radio surface brightness, hence remaining synchrotron self-absorbed to very short wavelengths. QSOs with compact components of this type are known to exist. The present observations show that any such components for BSOs must either show less than 1 f.u. peak or have a cutoff wavelength ≳3.5 mm, which implies a radio surface brightness about ten times that of any QSO. A comparison of the optical properties of QSOs and BSOs shows no clear systematic difference that might explain the lack of radio emission, and it appears likely that BSOs are similar to QSOs but have such low radio emission as to have escaped detection. This conclusion is not unexpected considering the relative luminosities of QSOs and galaxies, and it seems reasonable to assume that BSOs are not a separate class of stellar objects, but are QSOs with small intrinsic radio luminosity. (UK)

48923 NITROGEN ABUNDANCE OF ν INDI. Bell, R. A. (Royal Greenwich Observatory, Herstmonceux, Eng.). Mon. Notic. Roy. Astron. Soc.; 150: 15-21(1970).

A number of synthetic stellar spectra were computed in order to derive the nitrogen abundance of the subgiant ν Indi. These spectra cover the (0,0) sequence of the violet CN band and were computed for various nitrogen abundances. By comparing the computed spectra with the observations it was found that nitrogen is underabundant by a factor of about 1000 relative to the Sun. This confirms the result of Harmer and Pagel (1970) that the deficiency of nitrogen is greater than the deficiency of carbon and other metals in this star. (auth) (UK)

48924 EVOLUTION OF MASSIVE STARS AND STROEMGREN ZONES. Bisnovatyi-Kogan, G. S.; Syunyaev, R. A. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 361-2(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 441-2(Mar-Apr 1970).

The recombination and cooling times for Strömgren zones around massive stars that have left the main sequence are found to exceed the time required for a strong drop in the star's surface temperature. Observations of extended H II zones near yellow supergiants whose temperature is low, and whose ultraviolet radiation is therefore inadequate to maintain the zones, would provide a test for current stellar-evolution theory. (auth)

48925 VARIABLE SPECTRUM OF HD 217050. Gobros, Roshdi Azer (Shternberg Astronomical Inst., Moscow. Moscow Helwan Observatory, Egypt). Sov. Astron. AJ (Engl. Transl.); 14: 356-7(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 445-6(Mar-Apr 1970).

Intensity measurements are reported for absorption and emission lines in the Be variable HD 217050 during 1951–1960. The values appear to exhibit periodicities. (auth)

48926 STUDY BY PODURETS OF THE STABILITY OF RELATIVISTIC STAR CLUSTERS. Ipser, James R. (California Inst. of Tech., Pasadena). Sov. Astron. AJ (Engl. Transl.); 14: 364-5 (Sep-Oct 1970).
Translated from Astron. Zh.; 47: 452-3(Mar-Apr 1970).

There is a contradiction between the results of investigations by Podurets (1969) and by Ipser (1969a) of the stability against radial perturbations of a class of relativistic, truncated isothermal clusters. Here it is pointed out that Podurets' criterion for stability is correct, but that there exists an important error in his application of that criterion to the isothermal clusters. When Podurets' error is corrected, his criterion is found to yield no information about the stability of the isothermal clusters. The connection between Podurets' criterion for stability and criteria due to Ipser (1969b) is elucidated. (auth)

48927 PHOTOMETRY AND SPECTRAL CLASSIFICATION OF EARLY-TYPE STARS AWAY FROM THE GALACTIC PLANE. Hill, P. W. (Univ. Observatory, St. Andrews, Scotland). Mon. Notic. Roy. Astron. Soc.; 150: 23-34(1970).

Magnitudes and colors on the UBV system and MK spectral classifications are reported for 138 southern early-type stars away from the galactic plane. (auth) (UK)

48928 ANGULAR DIAMETER AND EFFECTIVE TEMPERATURE OF ZETA PUPPIS. Davis, J. (Univ. of Sydney); Morton, D. C.; Allen, L. R.; Brown, R. Hanbury. Mon. Notic. Roy. Astron. Soc.; 150: 45-54(1970).

Observations of the O_5f star ζ Pup with the stellar intensity interferometer at Narrabri Observatory have shown it to have an angular diameter of $(4.3 \pm 0.3) \times 10^{-3}$ after correction for limb-darkening. Combination of this result with photometric data and theoretical model atmospheres with ultraviolet line blanketing has yielded an effective temperature of 31,000 ± 2500°K. If ζ Pup is at a distance of 350 pc it has a radius of 16 $R_\odot$ and a mass of about 26 $M_\odot$ so that its surface gravity is 2.7×10^3 cm s^{-2}. The rather low temperature and low ultraviolet flux suggest that ζ Pup is not typical of early type O stars. (auth) (UK)

48929 ROTATIONALLY EXTENDED STELLAR ENVELOPES: γ CAS. Hutchings, J. B. (Dominion Astrophysical Observatory, Victoria, British Columbia). Mon. Notic. Roy. Astron. Soc.; 150: 55-66(1970).

New high time- and spectral-resolution observations of γ Cas revealed an intermittent periodicity (0.7 days) in emission line profile variations. Profiles of a number of weak spectral lines were obtained including two He I double emission lines and some O-type absorption lines. Absorption- and emission-line profiles were calculated for rotating stars by two independent methods. The observed profiles in the spectrum of γ Cas are fitted best by those computed for an O8 star rotating at break-up velocity and viewed at $i = 55 \pm 10°$. A detailed model of the star and extended envelope is derived and explanations of the line profile and other spectral variations are proposed. The method is applicable to all rotating B stars. (auth) (UK)

48930 EVOLUTION OF STAR CLUSTERS. Larson, Richard B. (Yale Univ. Observatory, New Haven). Mon. Notic. Roy. Astron. Soc.; 150: 93-110(1970).

The method for computing the evolution of star clusters which was developed in a previous paper (Larson 1970) is applied to calculating the evolution of a number of different models of star clusters. As in Paper I, the calculations refer only to the special case of equal masses, the stars all being assumed to have a mass of $1 M_\odot$. Three types of systems are considered, and their evolution is described in some detail: (1) a globular cluster of mass 2×10^5 $M_\odot$, (2) a galactic cluster of mass 100 $M_\odot$, and (3) a dense galactic nucleus of mass 10^9 $M_\odot$. In general, the results are in fair agreement with the predictions of classical relaxation theory, except that in some respects the classical picture is seen to be over-simplified. Some of the principal conclusions of the project are (1) the rate of evolution and the stellar escape rate are quite sensitive to the structure of the system; (2) the velocity distribution always tends to become strongly anisotropic in the outer part of the system; and (3) the existence of a tidal limit has a strong effect on the escape rate, and may increase it by a large factor compared to an isolated cluster. (auth) (UK)

48931 RED GIANTS IN OLD OPEN CLUSTERS. Cannon, R. D. (Royal Greenwich Observatory, Herstmonceux, Eng.). Mon. Notic. Roy. Astron. Soc.; 150: 111-35(1970).

A detailed comparison was made between the predictions of stellar evolution calculations and the observations of red giants in old open clusters. Colour-magnitude diagrams are presented for several such clusters, in which relative proper motions were used to eliminate nonmembers. The published observations of other old clusters are summarized. A prominent feature of all these clusters is a "clump" of red giants, centered near $M_v = +1$, $B-V = +1.0$, which is tentatively identified with the horizontal branch found in globular clusters. Comparison with various theoretical calculations, mostly by Iben (1965, 1968 and 1967) and Faulkner, (1966) supports this identification and indicates that the stars have a helium-burning core surrounded by a hydrogen-burning shell. The near constancy of the absolute magnitude of the clump is then interpreted as observational evidence for the occurrence of electron degeneracy in the cores of low-mass red giants. The use of the clump for crude determinations of cluster distances and reddening, and as evidence of the internal composition of the stars, is advocated. Finally, it is suggested that a large number of field red giants may be in the helium-burning phase of evolution, some of which may be used to investigate mass loss and internal mixing in evolving stars. (auth) (UK)

48932 PULSATIONAL STABILITY OF A MASSIVE STAR IN THE HELIUM BURNING PHASE. Mohan, C. (Univ. of Roorkee, India). Mon. Notic. Roy. Astron. Soc.; 150: 137-9(1970).

The effect of variation in opacity with pulsations on the dissipation of flux in the outer layers of a massive star in the helium-burning phase is discussed for the first four modes of pulsation. (auth) (UK)

48933 HALF-WIDTH OF THE Hα LINE AND RADIAL VELOCITIES IN THE CYGNUS LOOP. Doroshenko, V. T. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 237-40(Sep-Oct 1970).

Translated from Astron. Zh.; 47: 292-6(Mar-Apr 1970).

It was established from an analysis of Hα line half widths that the mean half width of Hα was 40 km/sec in the filaments, and 63 km/sec in the diffuse formations of the Cygnus Loop. There was also a difference in the rms deviations of the half widths: ±15 km/sec in the filaments, ±22 km/sec in the diffuse medium. It was therefore concluded that the model Poveda proposed for the filaments does not agree with the observations. The results obtained from an analysis of radial velocities in the Loop agree completely with Minkowski's findings: (1) the expansion velocity of the nebula is 110 km/sec; (2) the radial velocity of the object as a whole is +16 km/sec; (3) there is no difference between the radial velocities of the filaments and the diffuse formations. (auth)

48934 NONEQUILIBRIUM CHARACTER OF THE CONTINUOUS EMISSION OF CLASSICAL CEPHEIDS AT MAXIMUM LIGHT. Yakimova, N. N. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 241-9(Sep-Oct 1970).

Translated from Astron. Zh.; 47: 297-307(Mar-Apr 1970).

The possible excess at maximum light in the radiation of the classical Cepheids of the Galaxy over an equilibrium law is estimated statistically from the phase shift between the epochs of maximum radiant intensity and maximum contraction of the star. A comparison of the amplitudes of the photometric and geometric radii for over 50 variables shows that an excess is present. It increases both toward the low-temperature side of the observed band of instability and with increasing period of the Cepheid, that is, always toward stronger pulsations. Convection may be responsible for the excess radiation at maximum light. The need to consider convection when discussing Cepheid pulsations is emphasized. (auth)

48935 MILNE PROBLEM FOR ANISOTROPIC SCATTERING. Sobolev, V. V. (Leningrad Univ.). Sov. Astron. AJ (Engl. Transl.); 14: 202-7(Sep-Oct 1970).

Translated from Astron. Zh.; 47: 246-53(Mar-Apr 1970).

A discussion is given of the function $u(\eta)$ representing the relative intensity of the radiation diffusely transmitted by a semiinfinite atmosphere at the angle $\cos^{-1}\eta$ to the normal. The scattering indicatrix $x(\gamma)$ and the particle albedo λ may be arbitrary. Expressions and equations are given for determining the function $u(\eta)$. For the case of pure scattering, inequalities are obtained for the range of variation of the function $u_0(\eta)$ [the function $u(\eta)$ for $\lambda = 1$]. A simple approximate expression is also obtained for $u_0(\eta)$. (auth)

48936 COLD REGIONS OF INTERSTELLAR GAS AND THE FORMATION OF STELLAR ASSOCIATIONS. Pikel'ner, S. B. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 208-16(Sep-Oct 1970).

Translated from Astron. Zh.; 47: 254-64(Mar-Apr 1970).

Current views regarding the gravitational condensation and fragmentation of clouds meet with certain difficulties in explaining the formation of extended associations of low mean density. Another possible mechanism is therefore discussed. Interstellar gas is heated and ionized by low-energy cosmic rays or more probably by soft x rays. A layer of 10^{21} atoms/cm^2 will produce appreciable absorption of such x rays. Rayleigh–Taylor instability will lead to the formation of massive complexes. When a sufficient number of atoms have collected in a column, x rays

and ultraviolet radiation will be absorbed, serving to ionize the carbon. At the base of the complex a layer will form with a temperature as low as 6°K. The thickness of the layer will increase as the complex grows. Ultimately the layer will break up into stars whose mass may be even smaller than the solar mass. Through the adhesion of carbon to dust grains, and perhaps also because of the ultraviolet radiation from T Tauri stars which may ionize the carbon, the temperature of the layer will gradually rise, and the mass of the stars that form will accordingly increase. This effect may explain the observed lag in the formation of more massive stars. Although stars that have just formed will be free of the magnetic pressure that supports the layer, they will initially be held near the layer by its gravitation; but when the total mass of the stars becomes large enough the association will begin to fall toward the galactic plane. The star-formation process will terminate with the appearance of hot stars. The gas remaining in the complex will be dispersed in the form of an envelope. It is of interest to note that the number of atoms in such an envelope is $\approx 10^{21}$ cm^{-2}. The concentration of heavy absorbing clouds toward the inner side of spiral arms may occur because by the time massive stars have been formed in complexes they will have succeeded in traversing a considerable portion of the width of an arm and will be observed ahead of the dark young complexes. (auth)

48937 RATIO OF K TO A STARS IN LACERTA OB1. Weaver, Wm. Bruce (Case Western Reserve Univ., Cleveland). Astron. J.; 75: 938-40(Oct 1970).

An objective-prism survey of Lac OB1, in a 22.1 deg^2 area was undertaken in order to verify an excess of A stars found by Coyne, Mead, and Kaufman (1969) in this area. The excess was not verified and the region seems to have a normal ratio of K to A stars for its galactic latitude and longitude. (auth)

48938 STUDY OF THE BRIGHT A STARS. II. DISCUSSION OF SPECTRAL TYPES, COLORS, AND ROTATION. Cowley, Anne (Univ. of Michigan, Ann Arbor); Jaschek, Mercedes; Jaschek, Carlos. Astron. J.; 75: 941-5(Oct 1970).

New relations are presented between the mean UBV colors and spectral types, and between (V sin i) and spectral types. In addition, some remarks are made about the intrinsic colors of the supergiants, as well as the colors and rotational velocities of the Am and Ap stars. (auth)

48939 FOUR-COLOR AND Hβ PHOTOMETRY FOR OPEN CLUSTERS. V. NGC 752. Crawford, D. L.; Barnes, J. V. (Kitt Peak National Observatory, Tucson, Ariz.). Astron. J.; 75: 946-51(Oct 1970).

Observations were obtained at Kitt Peak for 37 stars which are members of the old open cluster NGC 752. Of these, 31 stars are F-type stars, five are late-type giants, and one is a blue straggler. Since the turnoff point from the main sequence is near spectral type F2, the data for the F stars will be used later as an aid in calibrating the photometric parameters in terms of absolute magnitude. The following conclusions were drawn for the cluster itself: (a) the interstellar reddening is constant for the cluster stars and is equal to $E(b-y) = 0.027 \pm 0.010$m (for one star). This is equivalent to $E(B-V) = 0.04$m. (b) The blanketing parameter $\delta m_1 = 0.010 \pm 0.007$m (one star), when corrected for reddening. Hence the metal abundance for the stars differs little from the Hyades or the Sun. (c) The values of δc_1 and $\delta(u-b)$ are strongly correlated with δV, the magnitude difference above a "zero-age line," for a given β; the slope $\delta V/\delta c_1$ is about 10. (d) The ultraviolet excess, $\delta(u-b)$, when corrected for reddening and the above luminosity effect, is about 0.03m. (auth)

48940 FOUR-COLOR AND Hβ PHOTOMETRY FOR OPEN CLUSTERS. VI. THE ASSOCIATION III CEPHEI. Crawford, D. L.; Barnes, J. V. (Kitt Peak National Observatory, Tucson, Ariz.). Astron. J.; 75: 952-6(Oct 1970).

Photoelectric photometry for 50 stars in the region of the OB association III Cep was obtained at Kitt Peak. It was determined that 26 of these stars are members of the association, and that the color excess for individual stars calculated by several different methods is in good agreement. It was concluded that a ratio of total-to-selective absorption $R(B-V) = A_V/E(B-V) = 3$ is appropriate for this region, and that the true distance modulus is $V_0 - M_V = 9.3$m. (auth)

48941 POSSIBLE HORIZONTAL-BRANCH STARS AT HIGH GALACTIC LATITUDES. V. Philip, A. G. Davis (State Univ. of New York, Albany). Astron. J.; 75: 957(Oct 1970).

Positions, B magnitudes, and spectra are given for ten new possible field horizontal-branch stars in regions at high galactic latitudes. (auth)

48942 PHOTOMETRY OF β CEPHEI. Gray, David F. (Univ. of Western Ontario, London). Astron. J.; 75: 958-61(Oct 1970).

Blue- and visual-band photometry of β Cep was done to determine the present value of the period of variability and to test the suggestion that the period is slowly increasing. An average period of 0.1904881 days was found for 1967-69 indicating the expected increase has not occurred. In addition, well-defined average light curves are given in B and V colors. (auth)

48943 ORBITAL ELEMENTS OF THE ECLIPSING BINARY VW CYGNI. Lacy, Claud H. (Univ. of Oklahoma, Norman). Astron. J.; 75: 961-2(Oct 1970).

New photometric orbital elements are given for VW Cygni based on observations made at the University of Oklahoma Observatory. Normal points, light curve, a chart and comparison sequence magnitudes are included. (auth)

48944 IONIZATION AND EXCITATION IN THE CRAB NEBULA. Trimble, Virginia (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. J.; 75: 926-32(Oct 1970).

Ratios involving emission lines of [O I], [O II], [O III], [N II], [S II], and hydrogen, derived from spectrograms and direct plates, are given for a number of points in the Crab Nebula. Emission from levels of high excitation is relatively strongest near the surface of the nebula. Emission from ions of high ionization potential, on the other hand, is concentrated toward the center of the nebula in both two and three dimensions. The intensity of the line of [O I] at λ6300 is estimated at 18 at Woltjer's (1958) scale, and the amount of neutral material at a given temperature required to produce this intensity has been calculated. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

48945 PAIRING EFFECT DUE TO THE L–S FORCE IN THE HIGH-DENSITY NEUTRON MATTER. Tamagaki, Ryozo (Kyoto Univ.). Soryushiron Kenkyu; 40: No. 4, D26-32(Dec 1969). (In Japanese).

The possibility that energy gaps may be caused in high-density neutron matter by the $^3P_2$ pairing effect due to the LS force in triplet odd state, one of the short-range characteristics of nuclear force, and the superfluidity, which is different from the $^1S_0$-pairing force, may be produced in neutron stars, was investigated. In the high-energy region, $^1S_0$ became repulsive because of its own core, $^3P_0$ and $^3P_1$ became repulsive also due to the LS force, and $^3P_2$ was the most attractive force among the LS force. Therefore, it is expected that the Fermi surface collapses due to the $^3P_2$ force, and superfluidity is produced at high density ($\rho \simeq 3 \times 10^{14} \sim 1 \times 10^{15}$ g cm^{-3}; $E_F \simeq 40 - 200$ MeV). The energy shift of two-nucleon Cooper pair on a Fermi sphere was calculated. It was found that any meaningful energy shift could not be obtained in the case of $E_F = 100$ to 150 MeV and $m^* = M^*/M = 1$. Then, it is hard to judge the existence of superfluidity due to $^3P_2$ pairing, unless the many-body effect is considered. The unitary transformation by Yoshida was extended as a generalized Bogoliubov transformation. An energy gap $\Delta_2(K_F) \simeq 3$ MeV was obtained for $E_F = 100$ to 150 MeV and $m^* = 1$, where the maximum value of $|mj|$ only was taken into account as a proper character for the $^3P_2$ state, and mj is equal to ±2. (NSA of Japan)

48946 INTERSTELLAR SCINTILLATION AND PULSAR INTENSITY VARIATIONS. Rickett, B. J. (Univ. of Manchester, Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc.; 150: 67-91 (1970).

Observations at Jodrell Bank of the intensity variations from ten pulsars are described. Two regimes are established. A pulse-to-pulse fluctuation is imposed at the source, simultaneously over a wide frequency range. Longer term variations show very fine frequency structure, the width of which varies between sources approximately as the inverse square of the dispersion measure. This slow fading is explained in terms of an interstellar scintillation model. Irregularities in the interstellar electron density with deviations of about 0.1% of the mean density and scale of about 10^{11} cm are deduced. (auth) (UK)

48947 FIVE NEW PULSARS. Davies, J. G.; Large, M. I.; Pickwick, A. C. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London); 227: 1123-4(12 Sep 1970).

Five new pulsars have been discovered in a systematic search at low galactic latitudes, using the Mark 1 radiotelescope at Jodrell Bank at 408 Mhz. These new pulsars were studied at 406, 408, 410, and 610 MHz to obtain information on their dispersion measures, pulse shapes, and periods, and the data obtained are shown in tabular form. Two of the new pulsars, JP 2003 and 2319 have periods in excess of 2 sec, and only one other known pulsar (NP 0527) has a larger period. JP 2003 has an unusually short

pulse. The most interesting of the new pulsars is JP 1858, which has the highest dispersion measure of any known pulsar; its distance appears to be 8 kpc and it lies at about 5 kpc from the galactic center, presumably in an inner spiral arm. The effect of scintillation broadening is discussed, and it is stated that this broadening should be detectable by measurement of high-dispersion pulsars at a number of frequencies, and should provide valuable further information on the clumpiness of the ionized interstellar medium. Scintillation broadening can be expected to limit the sensitivity of searches for high-dispersion pulsars, particularly those of short period, although in searches carried out so far at 408 MHz, scintillation broadening is probably less important than widening of the pulse by dispersion in the receiver bandwidth as a cause of loss of high-dispersion short-period pulsars. As scintillation broadening increases with the square of the dispersion measure, however, it may prove a serious obstacle to extending pulsar searches to remote regions of the Galaxy. The five new pulsars were designated JP 1845, 1858, 1953, 2003, and 2319. (UK)

48948 CARRIER OF THE INTERSTELLAR 89.190 GHz LINE. Klemperer, W. (Harvard Univ., Cambridge, Mass.). Nature (London): 227: 1230(19 Sep 1970).

It is stated that the unidentified interstellar line discovered by Snyder and Buhl (Nature 227: 862 (1970)) with estimated rest frequency of 89.190 GHz is well within the estimation error of the first rotational transition expected for the molecular ion HCO^+, which is isoelectronic with HCN and is extremely stable, and for which the molecular geometry is described. The observed line appears to be single rather than a component of a hyperfine multiplet. Mechanisms are suggested for the production of interstellar HCO^+. The spatial correlation of HCO^+ with H_2CO would be of interest. (UK)

48949 IRREGULARITIES IN THE CRAB PULSAR WOBBLE. Hoeg, E.; Lohsen, E. (Hamburger Sternwarte, Hamburg). Nature (London): 227: 1229-30(19 Sep 1970).

New measurements are reported of the arrival times of optical pulses from the Crab pulsar, NP 0532, obtained at Hamburg Observatory with a 60-cm refractor between Oct. 10, 1969 and April 9, 1970. Comparison of the results with those of other workers did not support the assumption of a periodic wobble of 77 days. The nature of the wobble in arrival times with a typical time scale of several months is still vague. The proposed interpretations in terms of a planetary companion or free precession cannot be maintained in their simple form, and it is not known whether the wobble is associated with speedup. From the data there is also the possibility that smaller speedup or a wobble of a time scale of about a week is present. (UK)

48950 APERTURE SYNTHESIS OBSERVATIONS OF W3 (IC 1795) AND DR 21 AT 2.695 GHz. Webster, W. J. Jr. (Case Western Reserve Univ., Cleveland); Altenhoff, Wilhelm J. Astron. J.: 75: 896-901(Oct 1970).

The NRAO 2.7-km interferometer was used to obtain aperture synthesis maps of the galactic radio source W3, associated with the optical H II region IC 1795, and DR 21, a small source in the Cygnus X complex. At the declination of W3, a synthesized half-power beamwidth (HPBW) of 6 by 7 arc sec, and at the declination of DR 21, a synthesized HPBW of 6 by 9 arc sec were obtained. Only the core of W3 was detected. This core is resolved into five small components with emission measures as high as 1.6×10^7 pc cm^{-6}. DR 21 appears to consist of a major component, a minor component, and a bridge between the two. It is shown that DR 21 can be interpreted as a dense core in an H II complex, W75. (auth)

48951 MASSIVE H I CLOUD SURROUNDING SOME COMPACT H II REGIONS. Bridle, A. H.; Kesteven, M. J. L. (Queen's Univ., Kingston, Ont.). Astron. J.: 75: 902-9 (Oct 1970).

Observations of 21-cm line emission from an area of sky surrounding the radio continuum sources near the nebulae K3-50 and NGC 6857 revealed an extensive neutral-hydrogen cloud centered on these sources. The mean radial velocity of the cloud coincides with that of the H 109α and H 137β recombination lines from this region. The 21-cm absorption spectrum of the radio-continuum complex was also derived. The neutral-hydrogen cloud contains between 100,000 and 250,000 $M_\odot$ and has a mean spin temperature of 85°K. The cloud is rotating and may also be contracting. It is suggested that the region may be an early stage in the formation of a star cluster. (auth)

48952 NEUTRAL-HYDROGEN SURVEY OF THE CYGNUS X REGION. McCutcheon, W. H.; Shuter, W. L. H. (Univ. of British Columbia, Vancouver). Astron. J.: 75: 910-13(Oct 1970).

The Cygnus X complex is found to be associated with the Orion arm by a comparison of the recombination-line and neutral-hydrogen velocities. In the longitude range of Cygnus X, the latitude distribution of hydrogen peaks at $b^{II} = +1°$ indicating that the DR sources are distributed approximately symmetrically with respect to the hydrogen. The virial theorem suggests that the complex is unstable but is, however, confined in the Z direction by the gravitational field of the galactic disk. (auth)

48953 NEUTRAL-HYDROGEN STUDY OF THE ORION REGION. Gordon, C. P. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. J.: 75: 914-25(Oct 1970).

A 21-cm study of the Orion region ($l^{II} = 191°$ to 223°, $b^{II} = -15.4°$ to $-22.4°$) was made with a HPBW of 10 arc min and a velocity resolution of 2 km/sec (NRAO 300-ft telescope). The over-all velocity pattern is one of rotation and is centered approximately on the nebula; no large-scale expansion was found. The general region of maximum H I is coincident with the optical H II. Barnard's Ring is not centered with respect to the rotating area nor does the Ring appear to bound either the rotating area or the region of increased H I. The Orion region as defined by H I extends at least 30° in longitude. The H I mass is ~70,000 $M_\odot$. There is no increase in H I around the Orion Nebula at the velocity of the H II recombination lines (-3 km/sec). An H I cloud at -10 km/sec covers ~30% of the Orion region. This study confirms the previous values of H I columnar densities in the direction of stars where Ly-α measurements have been made. The H I columnar densities found in the region of Blaauw's stellar groups a, b, c, and d are correlated inversely with the ages of the groups. Neutral-hydrogen absorption and emission data in the region of NGC 2024 are also presented. (auth)

Solar Phenomena

Refer also to abstracts 49078, 49080, and 49229.

48954 (AD-704116) THEORY OF SOLAR RADIO AND X-RAY PULSATION. Chiu, Yam T. (Aerospace Corp., El Segundo, Calif.). 1 Feb 1970. Contract F04701-69-C-0066. 54p. (TR-66(5260-10)-3; SAMSO-TR-70-138). CFSTI.

The observed modulation of some coronal microwave, x-ray, and Type 3 emissions into pulses of 10-sec intervals is a consequence of the stimulation of electron-cyclotron waves propagated in the whistler mode in dipole-like bipolar regions of dimension ~0.2 $R_\odot$. Assuming that a power-law spectrum, electrons with a slope similar to solar flare protons can be trapped in a bipolar region, it is shown that whistlers can be generated by pitch-angle instability. The resultant approximately 10-sec bounce motion of whistler wave trains leads to enhanced, modulated emission in microwave and x-ray frequencies by pitch-angle scattering of MeV electrons and to modulated Type 3 emission by scattering with coherent plasma waves. A direct prediction of the theory is the existence of sympathetic pulsations at two sources a fraction of a solar radius apart. A second test of the theory is that modulated Type 3 emission should show strong polarization. (auth) (USGRDR)

48955 (N-69-36441) CATALOGUE OF DATA ON SOLAR-TERRESTRIAL PHYSICS: SOLAR AND INTERPLANETARY PHENOMENA; IONOSPHERIC PHENOMENA; FLARE-ASSOCIATED EVENTS; GEOMAGNETIC PHENOMENA; AURORA; COSMIC RAYS; AIRGLOW, JULY 1957-FEBRUARY 1969. (World Data Center A, Coordination Office, Washington, D. C.). Jun 1969. 177p. CFSTI.

All the data associated with the various disciplines of solar-terrestrial physics received by the World Data Center-A (established in the U. S. A.), or known to be available are listed. In addition to sections listed in the title, there is a miscellaneous section that covers noctilucent clouds, meteorological rockets, and ozone. (TSS) (STAR)

48956 NEUTRINO ASTRONOMY OF THE SUN. PART II. METHODS OF NEUTRINO DETECTION. Kuchowicz, Bronislaw. Postepy Astron.; 18: 263-78(Sep 1970). (In Polish).

A survey of reactions induced by neutrinos is given. The applicability of these reactions to detection of neutrinos from the solar interior is discussed. There are two main kinds of neutrino-induced processes: inverse nuclear beta decay and elastic neutrino-electron scattering. Inverse beta decay can be detected indirectly by radiochemical methods (counting the number of radionuclides produced in the process) or directly by measuring the energetic final electron. The elastic scattering can be investigated only by a direct counting method; this kind of process is highly hypothetical and remains to be proved in the laboratory as a test for the recent formulation of the weak interaction theory. (auth)

48957 RESULTS OF SPECIAL OBSERVATIONS FOR THE PROTON FLARE PROJECT 1969. VI. SUMMARY OF THE JUNE 1969 EVENTS. Hakura, Yukio (Radio Research Lab., Tokyo). Denpa Kenkyusho Kiho; 16: No. 83, 104-12(Mar 1970). (In Japanese).

Solar-terrestrial events during the PFP Retrospective Interval 1969 (June 5-18) were investigated. Most of important solar flare and subsequent terrestrial disturbances were attributed to two very active regions, i.e., McMath plage regions 10134 and 10135, which were present on the Sun's visible disk during the interval. The δ configuration of sunspot magnetic field appeared in the region 10134 on June 5 and 6, warning possible onset of proton-producing flares in the regions. Occurrence frequency of x-ray bursts and sudden phase anomalies (SPA's) on several vlf radio waves received at Inubo Radio Wave Observatory also predicted the proton flares to occur during the first half of the interval. Actually, two outstanding solar flares of importance 3B occurred at 09:37 and 14:45 U.T. on June 5, being accompanied by giant x-ray and radio bursts. The first flare was overwhelmingly larger than the second one in all aspects of the solar-terrestrial relationship. A polar cap disturbance was observed on the phase of transpolar vlf radio waves received at Inubo. The disturbance on the NAA 17.8-kHz signal started at 20:30 U.T. on June 7, simultaneously with the onset of 5 to 21-MeV proton events observed by the earth-stationary satellite ATS-1. No solar proton event was observed in the 21 to 70-MeV channel on the same satellite. The low-energy-proton flux in the vicinity of the Earth increased abruptly with the onset of geomagnetic storm at 05:08 on June 8, reached the maximum at about 15 h U.T. (the time estimated from the polar cap disturbance), and recovered to the normal value by June 11. An energetic proton event was observed by the heliocentric spacecraft Pioneer-7, which was situated about 1.7×10^8 km distant from the Sun and at 100°E heliographic longitude relative to the Sun-Earth line. The event started before 21:30 on June 5 and decayed in 4 days. Low-energy-proton flux showed a considerable enhancement at the onset of magnetic storm at the spacecraft location. The major flare in the region 10134 at 09:37 on June 5 is the most possible cause of the Pioneer-7 and the ATS-1. In addition to the earth storm on June 7-11, two geomagnetic storms occurred during the Retrospective Interval. The second and the third storms may be related to the major flare that started at 16:13 on June 11 and at 21:04 on June 14, respectively. (auth) (Japan)

48958 SOLAR ECLIPSE MEASUREMENTS AT 16 AND 30 GHz. Wrixon, G. T. (Bell Telephone Labs., Murray Hill, N. J.). Nature (London); 227: 1231-2(19 Sep 1970).

Observations made on March 7, 1970 using the Crawford Hill sun tracker are described; at this location the eclipse was partial, with greatest magnitude 0.964. An accurate determination was made of the residual flux at the time of greatest magnitude as a proportion of the total solar flux, and from the data, in conjunction with data on the brightness distribution at the limb, the size of the radio sun at the two frequencies was determined. Details are given of the equipment and technique used. The fraction of total solar flux visible at the time of maximum eclipse was 5.6% at 30 and 6.53% at 16 GHz. Corrections were made for Moon contributions. The observations showed no evidence of limb brightening and were consistent with a flat brightness distribution at the limb. Values of the ratio of solar radio radius to optical radius were found to be 1.021 at 30 GHz and 1.031 at 16 GHz. The results also indicated that at 30 and 16 GHz, respectively, 4.2 and 6.2% of the total solar flux came from outside the optical disk. Comparisons are made with the results of other workers. (UK)

48959 THEORY OF TYPE III SOLAR RADIO BURSTS. II. Zheleznyakov, V. V.; Zaitsev, V. V. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 14: 250-60(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 308-21(Mar-Apr 1970).

An analysis is presented of the effects of the energy conversion of the plasma waves generated by a fast-electron stream into the fundamental- and second-harmonic radio emission of Type III bursts. The fundamental-harmonic radiation in Type III sources arises from the spontaneous (Rayleigh) scattering of plasma waves by thermal ions in the corona. Nonlinear conversion of plasma waves into electromagnetic waves at the fundamental-harmonic frequency is found to be unimportant for typical Type III bursts. The second-harmonic radiation is due to the Raman scattering of the excited plasma waves by fluctuations of the plasma-wave type, which are considerably enhanced over the thermal level. The enhancement results from Rayleigh scattering of the excited plasma waves that yield plasma waves. Estimates for the fast-electron concentration in the streams needed to explain the observed intensity of Type III bursts (roughly 1 to 10 el/cm^3) are in satisfactory agreement with the results of space-probe measurements of the interplanetary density of high-energy electrons produced in solar flares. Opportunities for an experimental test of the theory developed here are pointed out. An estimate is made of the minimum particle concentration in ion beams ($N_{i,\min} \approx 200$ ions/cm^3) required for exciting plasma waves in the corona, and it is shown that ions would have low efficiency for generating Type III bursts. (auth)

48960 POLARIZATION OF SOLAR RADIO EMISSION OBSERVED AFTER REFLECTION AT METER WAVELENGTHS. Fomichev, V. V.; Chertok, I. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 261-5(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 322-8(Mar-Apr 1970).

A discussion is given on the polarization characteristics of solar radio emission observed at meter wavelengths following reflection. The reflection of ordinary and extraordinary waves from corresponding layers of the corona is considered: It is shown that the reflected radio emission may be polarized; the sign of the polarization may correspond to both ordinary and extraordinary waves, and the degree of polarization may vary over a wide range. The polarization properties of the second harmonics of Type II and III bursts, the elements of "herringbone structure" in Type II bursts, paired bursts with reverse frequency drift, and burst exhibiting the "echo" phenomenon are analyzed. An explanation is given, in particular, for the change in the sign of the polarization at a fixed frequency that is observed in many Type III bursts. (auth)

48961 X AND RADIO EMISSION FROM LOCAL SOLAR SOURCES. Gel'freikh, G. B.; Zhitnik, I. A.; Livshits, M. A. (Main Astronomical Observatory, Moscow. Lebedev Inst. of Physics, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 266-73(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 329-39(Mar-Apr 1970).

Emission of sources over three spot groups in the x-ray region and in the centimeter radio range during the period June 16-30, 1967, is compared. X-radiation heliograms with a resolution ~3' in the regions 8 to 14 and 6 to 10 Å were obtained by the "Kosmos-166" satellite. Spectra of these same sources in the centimeter range were constructed using observations made with the large Pulkovo radio telescope with a resolution 1 to 3'. It was established that the relationship between the development of spot groups, x-ray, and radio emission is extremely complex: in addition to simultaneous variations, a case of a dropoff of x-ray and radio emission was observed without any changes in the spot group; in one case restoration of radio fluxes was not accompanied by a change in x radiation. With formation of a new group the radio source developed approximately a day after appearance of significant x radiation. It was demonstrated that within the framework of the bremsstrahlung radiation mechanism at short wavelengths $\lambda = 2$ to 3.2 cm (and not at $\lambda \approx 10$ cm, as used in earlier studies) radio observations limit the emission measure to the value EM $\gtrsim 0.1$ B. X-radiation data give $T \approx 2 \cdot 10^6$°K and EM ~ 1B = $3.2 \cdot 10^{49}$ cm^{-3}. (auth)

48962 PROPERTIES OF LOW-FREQUENCY OSCILLATORY CONVECTION IN A STRONG MAGNETIC FIELD. Zhugzhda, Yu. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 274-82(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 340-50(Mar-Apr 1970).

Low-frequency oscillatory convection is investigated in the linear approximation for a polytropic atmosphere with a strong vertical magnetic field. The general case of nonadiabatic oscillations is considered, and it is shown that the maximum increment is developed for oscillations with a convection-cell size such that $\omega \approx q$, where q is the reciprocal of the cooling time for a temperature irregularity having the given transverse size. Instability criteria are established for quasi-adiabatic and quasi-isothermal oscillations, together with their dependence on the temperature gradient and the temperature ratio at the boundaries of the atmosphere. Equations are derived for the thermal (convective) and wave energy flux transported by oscillatory convection. The properties of oscillatory convection are discussed with reference to the theory of sunspots. (auth)

48963 PROFILE OF THE 10,830-A LINE ON THE SOLAR DISK. Nguyen Ngan (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 283-6(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 351-6(Mar-Apr 1970).

The results are reported of photoelectric observations of the λ10,830 Å helium line in absorption on the solar disk. The line profile has a depression in the blue wing, which appears to be caused by the faint 10,829 Å component of the triplet. Various interpretations are considered. The model whereby the 10,830 Å

line would be formed in a thin layer with an optical depth $\tau_{10,830} = 0.10$ at the line center is incapable of explaining the fluctuations in the equivalent width on the solar disk and in the profile of the triplet as a whole. A model regarding the line as formed only in irregular formations having $\tau_{10,830} = 1.7$ yields a computed profile differing from the observed profile. A third possibility is suggested: that the line is formed both in a thin layer and in irregularities occupying 5% of the solar surface area and having $\tau_{10,830} \approx 2$. The depression detected in the blue wing of the line about 0.8 Å away from the line center cannot be explained entirely by the presence of the faint component. The depression also appears to result from absorption by spicules rising at a velocity of about 20 km/sec. (auth)

48964 COMPARISON OF THE OBSERVED MONTHLY WOLF NUMBERS AS SMOOTHED BY THE MOVING-AVERAGE AND WHITTAKER OPERATORS. Zhukov, L. V.; Muzalevskii, Yu. S. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 287-300(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 357-74(Mar-Apr 1970).

To arrive at a correct formulation of the problem of extrapolating series of relative sunspot numbers, it is suggested that an estimate be made of the mathematical expectation of the Zürich series of Wolf numbers, as obtained through probability smoothing by means of the Whittaker operator. The results of such a smoothing are presented, including the spectral-density curve for the autocorrelation function of semiannual values of the smoothed Wolf numbers and a histogram for the differential distribution function of monthly values of the Wolf number. The frequency characteristics of the moving-average and Whittaker operators are compared. In comparison with the Whittaker operator, the moving-average operator allows a considerable representation of high-frequency components of the initial process to remain with their phase distortion in the mathematical expectation that is obtained. Tables are given for the minima and maxima of the 11-yr cycles of relative sunspot numbers. The extrema are determined from the Zürich series of Wolf numbers as smoothed by the Whittaker operator. The results are compared with those obtained previously by other authors. (auth)

48965 SOLAR RADIO EMISSION ACTIVITY, 1965. Delys, C.; Gonze, R. Ciel Terre; 84: 361-5(Sep-Oct 1968). (In French).

The dates on which observations were made at the Humain–Rochefort radio astronomy station at 600 MHz are listed. The work of Wellens and Demily, who made the observations until June 30, 1965 and from July 1 on, respectively, is acknowledged. Tabulated data are presented on daily flux density and variability. The most important remarkable events observed during 1965 at 600 MHz and associated principal events are listed and briefly discussed. (Meteorol. Geoastrophys. Abstr.)

48966 SOLAR RADIO EMISSION ACTIVITY, 1964. Delys, C.; Gonze, R. Ciel Terre; 84: 269-73(Jul-Aug 1968). (In French).

The results of observations made of the Sun at 600 MHz at the Humain–Rochefort radio astronomy station in 1960 are summarized. The observations were made daily at sunrise and sunset. The tables presented comprise mean daily flux density and mean daily variability at 600 MHz, a list of the most important remarkable events observed in 1964 at 600 MHz, and associated events. (Meteorol. Geoastrophys. Abstr.)

48967 SOME FEATURES OF THE ENERGY SPECTRUM O SOLAR COSMIC RAYS. Miroshnichenko, L. I. Kosm. Luchi; No. 10, 50-5(1969). (In Russian).

Some features of the energy spectrum of solar cosmic rays were analyzed. The roles of various factors that determine the form of the spectrum near the Earth's orbit (drift, anti-Fermi deceleration, convective transfer, diffusion, and prolonged emission from the acceleration region) were examined. A number of flares were taken as an example to show that experimental data deviate from the exponential law of the rigidity spectrum of solar particles suggested by Freier and Webber. Probable causes of this disagreement are discussed. (auth) (Meteorol. Geoastrophys. Abstr.)

48968 ELECTRIC FIELD IN THE SOLAR CORONAL EXOSPHERE AND THE SOLAR WIND. Sen, Hari K. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Franklin Inst.; 287: 451-6(Jun 1969).

The solar coronal exosphere (fixed at a level where the mean free path is comparable with the scale height) is shown to act like the sheath in a laboratory discharge that builds up an excess positive charge and electric field. Equality of flux for the charged particles (protons and electrons) at the exosphere is assumed. The exospheric electric potential (for a coronal temperature of 10^6 K) is found to be about 325 V, which makes the protons virtually weightless. The exospheric sheath potential accelerates the thermal protons to a velocity of 258 km/sec with which they coast to the Earth. The proton density in transit varies approximately as the inverse square law, and is 3 cm^{-3} near the Earth. Higher velocities and densities are obtained for higher coronal temperatures. An estimate of the exospheric transition region is obtained by applying the hydrodynamic theory of ambipolar diffusion in a gravitational field to the "observed" coronal density distribution. The ratio of the electric to the gravitational force on the proton builds up from its hydrostatic value of ½ at 2.4 $R_\odot$ to 1 at 8$R_\odot$ from the solar center. (auth)

Galaxies

Refer also to abstract 49158.

48969 SCATTERING OF COSMIC X RAYS BY INTERSTELLAR DUST GRAINS. Hayakawa, Satio. (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 1224-30(May 1970).

X rays from celestial sources are scattered by interstellar dust grains. The apparent angular size of an x-ray source increases due to scattering, depending on the distance of the x-ray source, the wavelength of x rays and the properties of dust grains. Hence the observation of the scattering effect provides a new means of obtaining the distances of x-ray sources and various pieces of information on interstellar dust grains. Since the angular size is proportional to λ/a, where λ is the wavelength of x rays and a the radius of grains, the observation of the scattering effect is feasible at wavelengths greater than 10Å. It is suggested that the wavelength slightly longer than the K edge of oxygen is most advantageous if silicate or silicate-ice mantle is the major component of interstellar dust grains. (auth)

48970 COMPARISONS OF GALAXY SIZES. Genkin, I. L.; Genkina, L. M. (Astrophysical Inst., Alma-Ata, USSR). Sov. Astron. AJ (Engl. Transl.); 14: 353-5(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 443-5(Mar-Apr 1970).

The effective diameters of galaxies and the diameters determined in Holmberg's microphotometric system were compared with the micrometric diameters in de Vaucouleurs' catalog. The ratio D_{Ho}/D_{DV} ranged from 2.8 for elliptical galaxies to 1.6 for late spirals. The ratio $D_{DV}/D_e = 2.6$ for spirals and about 1.4 for giant elliptical galaxies. (auth).

48971 QUASAR-LIKE PHENOMENA AND ACCUMULATION OF INTERGALACTIC GAS BY GALAXIES. Ozernoi, L. M. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 217-21(Sep-Oct 1970).
Translated from Astron. Zh.; 47: 265-70(Mar-Apr 1970).

It is shown that the rate at which intergalactic gas accumulates into galactic nuclei during the "quiet" phase of their evolution should increase along an extended Hubble sequence. This increase can explain the parallel increase in the power radiated nonthermally from supermassive, rotating magnetoplasma cores (magnetoids), which presumably are present in galactic nuclei during the "excited" phase of their evolution and are responsible for quasar-like phenomena. The accumulation of intergalactic gas may lead to the repeated formation of magnetoids in galactic nuclei, especially if the intragalactic gas becomes exhausted. Observations are proposed for choosing between intra- and extragalactic sources of gas for magnetoid formation. (auth)

48972 SYSTEM OF STELLAR ASSOCIATIONS OF THE LARGE MAGELLANIC CLOUD. Hodge, Paul W.; Lucke, Peter B. (Univ. of Washington, Seattle). Astron. J.; 75: 933-7 (Oct 1970).

From a study of the 122 recognized stellar O associations in the Large Magellanic Cloud, it was found that the mean diameter is 78 pc, similar to the mean diameter of stellar associations recognized in the solar neighborhood. The mean number of stars with absolute magnitudes brighter than about –4 per 10^3 projected square parsecs in the associations is 19, while the mean total population of such stars is 18 per stellar association. Both of these figures are somewhat larger than the populations and the population densities of such stars in stellar associations near the Sun. There is a considerable spread in the densities of bright stars in the LMC's associations, but a general over-all correlation exists between the size of the association and the total number of stars. Fifteen "star clouds" were recognized and these have a mean diameter of 225 pc, with total populations averaging 32 stars brighter than $M_V = -4.2$. In dimensions these objects are more similar to the objects studied in M31 by van den Bergh than are the majority of the stellar associations in the LMC or the Galaxy. There is, however, no obvious discontinuity between

the characteristics of the two kinds of objects. The radial distribution of the associations is shown. It appears to be considerably steeper than the radial distribution of stars or H I in the LMC. Sixteen of the associations contain clusters that are probably coexistent physically, only a few of which might be superimposed by chance on the association. These clusters seem to be similar to the nuclei found in some stellar associations of the Galaxy. A total of 96 of the 122 recognized stellar associations contain H II regions. The Hα fluxes of these H II regions are related to the mean stellar densities of the associations. (auth)

48973 MASSES AND MASS–LUMINOSITY RATIO FOR GALAXIES. Vorontsov-Vel'yaminov, B. A. (Shternberg State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 14: 222-6(Sep-Oct 1970).

Translated from Astron. Zh.; 47: 271-6(Mar-Apr 1970).

A compilation of 215 determinations of rotation or dispersion of internal velocities for 141 galaxies and 28 nuclear regions was used to obtain linear equations relating the masses and luminosities for E–SO and SO–Irr galaxies. The masses of the galaxies run from 10^9 to 2×10^{12} solar masses. The masses of the nuclear regions are 6 to 100 times smaller than the total masses, and their diameters are 5 to 40 times smaller than the total diameters. The M: L ratio was about eight (for 100 objects) and is independent of the type of galaxy and its color for all the galaxies. For the supergiant E galaxies, M: L is significantly larger, being about 20 on the average; in rare instances it goes as high as 50. (auth)

48974 TIDAL EFFECT AND THE FORMATION OF BRIDGES AND TAILS IN GALAXIES. II. FORMATION OF TAILS IN INTERACTING GALAXIES DURING CLOSE APPROACHES. Tashpulatov, N. (Leningrad Univ.). Sov. Astron. AJ (Engl. Transl.); 14: 227-36(Sep-Oct 1970).

Translated from Astron. Zh.; 47: 277-91(Mar-Apr 1970).

The outflow of material from the vertex of a homogeneous prolate galaxy due to the close approach of another (point) galaxy is treated hydrodynamically. The relative orbit of the point galaxy is assumed parabolic with pericenter distance q. The ellipsoidal galaxy is assumed to rotate at some constant angular velocity. Computations are performed for two values of the mass ratio and three values of q. The differential equations describing the motion of a hydrodynamic mass element have been integrated numerically by the Runge–Kutta method. All the computations indicate that bridges and tails will form in interacting galaxies. The principal results of the calculations are presented graphically. (auth)

48975 COMPOSITIONS OF GARNETS IN INTERSTELLAR DUST. Manning, P. G. (Dept. of Energy, Mines, and Resources, Ottawa). Nature (London); 227: 1121-3(12 Sep 1970).

It has been shown that absorption bands in the optical spectra of the supernova in NGC 4496 correlate well with d–d bands of Fe^{3+} in yttrium iron garnet and Fe^{2+} interrestrial almandine, $Fe_3^{2+}Al_2^{3+}Si_3O_{12}$, and the present author suggested that the 4430 Å band in supernova spectra is a result of Fe^{3+} in a silicate matrix, the band resembling that marking the $^6Al(S) \rightarrow {}^4Al^4E(G)$ transition in octahedral Fe^{3+} in an andradite garnet, $Ca_3^{2+}Fe_2^{3+}Si_3O_{12}$. It is likely that interstellar garnets are silicate-based, and approximate formulae are proposed for these garnets, based on the identification of two interstellar absorption bands, the energies of which can be related to garnet compositions. It is thought to be likely that the interstellar garnet is an andradite in which a significant proportion of Si^{4+} ions has been replaced by Fe^{3+} and possibly Al^{3+} ions. There is also evidence that supernovae in NGC 2713 and 4496 contain considerably more almandine than andradite-type garnet. A suggested approximate formula is $Ca_3(Fe_{1.2}^{2+}Ti_{0.8}^{4+})(Si_{2.2}^{4+}Al_{0.8}^{3+})(Si_{1.2}^{4+}Fe_{1.8}^{3+})O_{12}$. Thus if current assignment of bands in supernovae spectra is correct, interstellar dust contains two garnets, one of almandine type and the other a substituted andradite with appreciable amounts of Fe^{3+} and, possibly, Al^{3+} in Si^{4+} sites. (UK)

48976 DUST-UP IN SPACE. Duley, W. W. (York Univ., Toronto). Nature (London); 227: 1277(19 Sep 1970).

It is stated that with extension of interstellar extinction curves into the vacuum uv, made possible by rocket and satellite observations, there has been a tendency to "duplicate" these curves with increasingly complex mixtures of scattering particles. Claims have been made that a fit between theoretical and observed extinction curves provides justification for a particular grain model. A case in point is a recent paper on interstellar extinction by graphite, iron, and silicate grains (Nature 227: 51 (1970)) in which an attempt is made to fit the extinction curve over the wavelength range $0.5 \leq \lambda^{-1} \leq 7\ \mu m^{-1}$ with Mie scattering by a mixture of three types of particles. Reasons are advanced why such agreement as exists must be considered fortuitous. (UK)

48977 GALACTIC X-RAY BACKGROUND COMPONENT: THE DIFFICULTIES WITH THE INNER-BREMSSTRAHLUNG. de Freitas Pacheco, J. A. (Nice Observatory, France). Nature (London); 277: 1230-1(19 Sep 1970).

It has been stated (Brown, R. L., Astrophys. J., 159: L187 (1970)) that the inner bremsstrahlung associated with suprathermal particles can account for the observed x radiation at 0.26 keV in the galactic plane. The energy spectrum of the suprathermal particles used in the calculations was obtained by multiplying the observed spectrum by a demodulating factor to take into account the influence of the solar wind, but self-absorption, which is important for energies of the order of 0.26 keV, was not taken into account. Furthermore, the ionization rate of the interstellar gas by these suprathermal particles imposes limits on the energy cutoff of the spectrum and on the particle flux. The calculation presented shows that, when the gas self-absorption and the ionization rate are included, the inner bremsstrahlung produces an x-ray flux several orders of magnitude smaller. Account is taken of the secondary ionization, the presence of particles other than protons in the cosmic-ray chemical composition, and the presence of 10% He in the interstellar gas. It is concluded that the x-ray flux cannot be the result of inner bremsstrahlung. (UK)

Cosmology

Refer also to abstracts 49438 and 49595.

48978 (N–70–18915) SPATIAL DISTRIBUTION OF THE DIFFUSE COMPONENT OF COSMIC X RAYS. Schwartz, Daniel Alan (California Univ., La Jolla, San Diego. Dept. of Physics). Sep 1969. Contract NAS5-3177. 149p. (NASA-CR-10817). CFSTI. Thesis.

Data from the OSO-3 x-ray detector were analyzed in five logarithmically spaced energy channels to study the spectrum and angular distribution of the diffuse component in cosmic x rays. Background phototube noise, counts due to cosmic-induced gamma rays, and counts due to gamma rays associated with the beta decay of Na-24 were subtracted from raw counting rates and all known galactic discrete sources were avoided. Results established the existence of a diffuse, apparently isotropic component of extraterrestrial x rays in the energy range 0.25×10^3 keV. The absence of anisotropy, to roughly 20% limits, strongly suggested that these x rays have extragalactic origin. Excess emission areas in the lowest channel of 0.012 ± 0.004 photons (sq cm sec rad)-1 at 10 keV indicated sources at distances of the order of the Hubble radius as significant contributors to the diffuse component. (STAR)

48979 KINETIC NEUTRINO THEORY IN ANISOTROPIC COSMOLOGICAL MODELS. Doroshkevich, A. G.; Zel'dovich, Ya. B.; Novikov, I. D. (Inst. of Applied Mathematics, Moscow). pp 15-25 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

A possibility of an essential anisotropic extension of the Universe at early stages is being widely discussed in the literature. In analyzing the extension dynamics and physical processes at the anisotropic stage it is necessary to take into account the effect of weakly interacting particles that were available in primordial matter. (auth)

48980 WAVE FIELDS IN OUTER SPACE DURING GRAVITATIONAL COLLAPSE. Patashinskii, A. Z.; Khar'kov, A. A. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz.; 59: 574-83(Aug 1970). (In Russian).

The problem of wave fields in space surrounding a collapsing slightly nonspherical mass is solved. The role of such fields may be played by an electromagnetic field produced by a collapsing object or the nonspherical part of the metric. There is a wave region for wave processes near the gravitational radius. Nonsingular solutions are obtained in this region. Matching these solutions with those for a region removed at a greater distance from the gravitational radius permits one to conclude that, during collapse, the external wave fields disappear exponentially with a characteristic time $\tau_0 \sim r_g/c$. For an object with a mass of several solar mass units this signifies a very rapid ($\tau_0 \sim 10^{-5}$ sec) disappearance of the field in space when the body boundary approaches the gravitational radius. (auth)

48981 NONLINEAR LAGRANGIANS AND COSMOLOGICAL THEORY. Buchdahl, H. A. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc.; 150: 1-8(1970).

In relativistic cosmology the theory of uniform model universes is based on Einstein's equations, which derive from a variational principle the field-Lagrangian L of which is the scalar curvature R to within an arbitrary additive constant. In this work the possibility of taking L to be a more general invariant of the Riemann tensor is contemplated. The consequences of choosing L to be a function of ϕ of R alone are tentatively examined under specialized circumstances, with particular attention to an open world-model oscillating between nonsingular states. Difficulties revolving about the actual form which ϕ might take are discussed. (auth) (UK)

Planetary Phenomena

48982 HIGH-VOLTAGE ELECTRON MICROSCOPE STUDIES OF FOSSIL NUCLEAR-PARTICLE TRACKS IN EXTRATERRESTRIAL MATTER. Borg, J. (CNRS, Orsay, France); Dran, J. C.; Durrieu, L.; Jouret, C.; Maurette, M. Earth Planet. Sci. Lett.; 8: 379-86(Jul 1970).

Fossil nuclear-particle tracks in lunar and meteoritic materials were searched for with the 1-MeV electron microscope of the Institut d'Optique Electronique du C.N.R.S., Toulouse, both before and after a chemical etching of the samples. Evidences for very high densities of nonetchable tracks of two different kinds have been observed only in the finest fraction (<400 mesh) of the lunar soil from the Apollo 11 and 12 missions but not in the type I carbonaceous chondrite Orgueil, in the dark part of the solar type gas-rich Pesyanoe enstatite achondrite, or in crystals extracted from lunar rock 10047. These track densities can exceed by a factor of 100, the densities of etched tracks measured in the same lunar soil samples. Some implications of the present results concerning lunar and meteoritic matter, the ancient fluxes of solar particles, and solid-state physics are briefly discussed. (auth)

48983 NICKEL-IRON IN LUNAR ANORTHOSITES. Dickey, John S. Jr. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Earth Planet. Sci. Lett.; 8: 387-92(Jul 1970).

Nickel-iron grains in anorthositic particles found in lunar soil from Mare Tranquilitatis contain 6 to 29% Ni. Similar metal grains in the more common Ti-rich basalts are nearly pure Fe. Either the anorthosites have been selectively contaminated by meteoritic metal, or Ni has been magmatically fractionated. If the anorthosites and basalts of Mare Tranquilitatis are related by magmatic fractionation, the process probably involved fractional crystallization followed by partial fusion of pyroxene-rich cumulates. (auth)

48984 ANTINEUTRINO LUMINOSITY OF THE EARTH. Marx, G.; Lux, I. (Inst. of Nuclear Research, Budapest). pp 28-34 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

The chemical structure of the Earth is rather unknown. The abundance of radioactive elements may be obtained from the measurement of the antineutrino flux at sea level. This flux is estimated for different geochemical assumptions. The possibilities for the detection of terrestrial antineutrinos are discussed. (auth)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 48280, 48564, and 49796.

48985 (BMBW-FBK-70-8-A) DEPENDENCE OF THE BACKSCATTERING FACTOR OF ELECTRONS ON THE SURFACE ROUGHNESS OF METALS. Tautenhahn, F.; Puetz, W.; von Erichsen, L. (Bonn Univ. (West Germany). Institut fuer Physikalische Chemie). Jul 1970. 54p. (In German). Dep. CFSTI (U. S. Sales Only).

The backscattering factor was investigated as a function of surface roughness of the carrier material of the radioactive nuclide for metals of different atomic numbers and β emitters of different maximum energies. A sensitive dependence of the backscattering factor on the surface roughness of the metallic support was observed. For example, in the roughness range from 0 to 100μ the backscattering factor decreased by 50% in the case of ^{63}Ni. This effect decreased continuously with higher maximum β-particle energies, and could not be observed at energies above ~2 MeV. (auth)

48986 CALCULATION OF ATOMIC CROSS SECTIONS OF SOLID ELEMENTS. Marais, Bernard (Centre National de la Recherche Scientifique, Toulouse). Compt. Rend., Ser. B; 271: 103-6(15 Jul 1970). (In French).

A new model of the electrostatic potential in the neighborhood of an atom is suggested; this model takes into account vibrations of the nucleus about its mean position. With this mathematical form, an absolute calculation of the elastic and inelastic cross sections can be made; the expressions obtained can be used directly. (auth) (France)

48987 ELECTRON EMISSION UNDER ION BOMBARDMENT: ENERGY SPECTRA. Viel, Louis; Colombie, Nicole; Fagot, Bernard; Fert, Charles (Toulouse Univ.). Compt. Rend., Ser. B; 271: 239-41(20 Jul 1970). (In French).

Energy spectra of electrons emitted from an Mg target during bombardment by 40-keV Kr^+ ions were measured. Narrow well-defined peaks of Auger electrons were accompanied by secondary peaks indicating energy losses suffered by the electrons in traversing the surface layers of the target. (A.G.W.)

48988 INTERACTION OF BETA PARTICLES WITH THIN FILMS. Hug, M. S.; Mowla, G. (Univ. of Chittagong, Pakistan). Health Phys.; 18: 734-6(Jun 1970).

Absorption of monochromatic beta particles by aluminium was studied extending the range of thickness of absorber used by previous workers. ^{32}P, ^{89}Sr, ^{137}Cs, ^{35}S and ^{14}C were used with absorbers of between 10 μg/cm^2 and 100 mg/cm^2. The mass absorption coefficient (μ/p) obtained was $14E^{-0.16}$ cm^2/g, the difference from previously published figures being due to geometry. However it was observed that there was no absorption in the region 10 to 700 μg/cm^2. Back scatter experiments were also carried out and it was shown that there was no back scattering from aluminum foils of thickness 10 to 300 μg/cm^2 so that foils of up to 300 μg/cm^2 can be used for source mounting. (UK)

48989 NEW TYPE OF ION SOURCE. Fitch, R. K. (Univ. of Aston, Birmingham, Eng.); Mulvey, T.; Thatcher, W. J.; McIlraith, A. H. J. Phys., D (London); 3: 1399-1402(Sep 1970).

A new type of positive ion source is described, based on an electrostatic charged particle oscillator described by McIlraith in 1966. The new source is especially suitable for the controlled removal of material from solid surfaces or for the thinning of specimens for electron microscopy. Ion current densities up to 300 μA cm^{-2} were readily obtained. Large areas of sample can be bombarded and the working pressure of the device is low, normally below 10^{-3} torr. A specimen of OFHC copper exposed to a beam of argon ions at a density of 100 μA cm^{-2} was eroded at the rate of 1 μm per hour, corresponding to a removal rate of about four atoms per incident ion. (auth) (UK)

48990 PRODUCTION AND STUDY OF A SUPERSONIC MOLECULAR BEAM OF PLANE SYMMETRY. Treguier, Jean-Pierre; Hagene, Monique; Pasquerault, Daniele (Rennes Univ., France). Rev. Phys. Appl.; 5: 343-50(Apr 1970). (In French).

A supersonic beam apparatus with plane symmetry is described and studied. The Mach number M in the continuum flow was determined by a half empirical, half theoretical method, and was shown to approach a limit. An experimental study of the intensity and its distribution in the directions perpendicular to the beam axis, was made as a function of the upstream nozzle pressure and the nozzle skimmer distance. The intensity obtained in the optimal conditions was 2.1×10^{18} mol srd^{-1} s^{-1} for nitrogen. This represented 15% of the calculated theoretical value. The performances of the apparatus were compared to those of an oven beam and a supersonic beam with axial symmetry. (auth) (France)

48991 INVESTIGATION OF SLOWING DOWN OF LOW ENERGY PROTONS IN SiO_2 FILMS. Zhukova, G. A.; Kessel'man, V. S.; Mordkovich, V. N.; Zabotina, G. F. Zh. Eksp. Teor. Fiz.; 59: 413-18(Aug 1970). (In Russian).

The method described for determining the range of charged particles in dielectric targets is based on deposition of dielectric films on the surface of semiconducting plates and on a study of the radiative changes in the characteristics of the dielectric–semiconductor system. Slowing down of 15 to 50-keV protons in SiO_2 films is studied, and the mean and maximal path lengths are determined. The experimental results are compared with the Lindhard theory. (auth)

48992 HIGH CURRENT LOW VOLTAGE ELECTRON BOMBARDER FOR EXCITATION OF A MOLECULAR BEAM. Freund, Robert S. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Sci. Instrum.; 41: 1213-18(Aug 1970).

An electron bombarder for producing intense beams of metastable atoms and molecules was constructed and operated. The cathode is a 1 × 5 cm nickel matrix with a BaSrO coating. It was found to resist poisoning by a variety of gases. The anode consists

of 10 parallel channels, each 0.1 cm wide, 5 cm long, and 1 cm high. Anode currents of up to 380 mA at 20 V were obtained. Beams of N_2, helium, and argon contained approximately 10^{11} metastables/sec. (auth)

48993 RESONANT CHARGE EXCHANGE OF IONS IN ATOMS WITH UNFILLED ELECTRON SHELLS. Duman, E. L.; Smirnov, B. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 61-5(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 91-6(Jan 1970).

The exchange interaction of an ion with its atom is calculated when they are separated by a large distance for the case in which the outer electron shells of the ion and atom are not filled. The result obtained is used to compute the cross section for resonant charge exchange between the ion and atom. (auth)

48994 EFFECTIVE CROSS SECTIONS FOR IONIZATION AND EXCITATION OF HELIUM BY ELECTRON IMPACT. Alkhazov, G. D. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 66-73(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 97-107(Jan 1970).

Semiempirical equations are given for the ionization and excitation cross sections for helium bombarded by nonrelativistic electrons. The equations were adjusted to agree with experiment for small incident energies; at high energies they have the asymptotic form implied by theory. The equations can be used to calculate an ionization cascade in helium. The error at low energies is 20 to 30%; at high energies the error is about 5%. (auth)

48995 DIFFUSION OF HELIUM IONS IN HELIUM ACROSS A MAGNETIC FIELD. Pasechnik, L. L.; Yagola, V. V. (Inst. of Physics, Kiev). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 74-7(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 108-12(Jan 1970).

The phase technique is used to measure the ion transit time from the axis to the wall of a cylindrical chamber. Measured values of $D_\perp$, the coefficient for diffusion across a magnetic field, are presented as functions of the magnetic field for various gas pressures. Good agreement is obtained with the Townsend equation for the diffusion coefficient of charges in a magnetic field. The effective frequency of collisions of helium ions with atoms is determined at various pressures. The values of the collision frequency are in good agreement with those obtained earlier from measurements of the mobility of helium ions in helium. (auth)

48996 ELECTRON GUN FOR ATOMIC BEAM RECOIL SCATTERING EXPERIMENTS. Collins, R. E.; Aubrey, B. B.; Einser, P. N.; Celotta, R. J. (New York Univ., Bronx, N. Y.). Rev. Sci. Instrum.; 41: 1403-8(Oct 1970).

A versatile low energy electron gun suitable for electron–atom scattering experiments has been designed utilizing photoetched grids and precision ceramic spacers which stack onto ceramic rods. Diagnostic techniques are described which determine the absolute electron energy to within ±0.1 eV. Electron guns which operate over the energy range 0.1–25 eV with currents up to 10 mA and energy spreads as low as 0.2 eV have been built using the design presented here. (auth)

48997 PRODUCTION OF IONS BY IONIZATION OF NEUTRAL PARTICLES ON A HELIUM GAS TARGET. Savchenko, O. Ya. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 222-4(Aug 1970).

Translated from Zh. Tekh. Fiz.; 40: 305-9(Feb 1970).

A description is given of an ion source in which the ion flux is produced by ionizing a flux of fast neutral particles on a helium gas target. The source consists of an arc proton source, two grids to produce a proton beam from the arc plasma, and two charge-exchange tubes. The first converts the ions to neutral atoms, while these atoms are ionized on helium atoms in the second. The limiting characteristics of the ion flux are as follows. The H^+ current has an amplitude of about 1 A, while the N^+ current has an amplitude of about 150 mA, for an ion energy of 14 kV, a pulse length of 100 μsec, a distance of 700 mm, and a cross section of 15 cm^2. (auth)

48998 SCATTERING OF ATOMIC HELIUM AND MOLECULAR DEUTERIUM BEAMS FROM PLATINUM (111) SURFACES CHARACTERIZED BY LEED. Smith, D. L.; Merrill, R. P. (Univ. of California, Berkeley). J. Chem. Phys.; 53: 3588-94(1 Nov 1970).

The scattering of helium and deuterium from platinum (111) surfaces whose crystallographic order and structure have been characterized by in situ LEED measurements in an ultrahigh vacuum system ($\approx 10^{-10}$ torr) is described. The effect of surface temperature, gas temperature, incidence angle, and lattice stiffness are in qualitative agreement with the cube theories and thermal roughening of the surface. Indications of the excitation of internal degrees of freedom are discussed. The use of a dc detection system allows mass balances between the incident and scattered beam, which agree within 3%. (auth)

Atomic and Molecular Properties

Refer also to abstracts 48921 and 49260.

48999 (SC-M-70-584) STARK-PROFILE CALCULATIONS FOR THE FIRST FOUR HYDROGEN BALMER LINES. Hill, R. A. (Sandia Labs., Albuquerque, N. Mex.); Kepple, Paul (Naval Research Lab., Washington, D. C.). Sep 1970. 55p. Dep. CFSTI.

Stark-broadened line profiles for the first four hydrogen Balmer lines were computed for electron densities in the range $10^{13} \leq N_e \leq 10^{19}$ cm^{-3} and for electron temperatures in the range $10^4 \leq T_e \leq 4 \times 10^4$ °K. These profiles have been calculated both with and without the effects of inelastic collisions between perturbing electrons and radiators. Fractional-intensity widths of these profiles were computed and tabulated as a function of electron density and temperature. (auth)

49000 (UCRL-50911) EQUATION OF STATE OF H_2 AND D_2 BETWEEN 3 AND 10 cc/mole AND TO 10,000°K. Ross, Marvin (California Univ., Livermore. Lawrence Radiation Lab.). [1970]. 14p. Dep. CFSTI.

A theoretical model was used to analyze the limited experimental data on molecular H_2 and D_2 and then to calculate the equation of state of these isotopes to 10,000°K and 3 cc/mole. The usefulness of shock-wave experiments in predicting the equation of state in the regions not covered by the experiments is analyzed. It is concluded that the most useful experiments will be those starting from the liquid and leading to the highest final temperatures, and not necessarily to the highest compressions. (auth)

49001 RETARDED VAN DER WAALS INTERACTIONS. I. SIMPLE ATOMS. Getzin, Paula Mayer; Karplus, M. (Columbia Univ., New York. Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 53: 2100-6(1 Sep 1970).

The effect of retardation on the dipole dispersion interaction between atoms was determined. By the use of accurate frequency-dependent polarizabilities, quantitative calculations of the retardation correction to the interaction of (H, H), (H, He^+), (He^+, He^+), (H, He), and (He, He), as well as to the three-body system (He, He, He), were made. The procedure used was to evaluate the Casimir–Polder integral for two atoms and its three-body extension directly so as to obtain results correct for all R. Although the corrections to the limiting behavior ($1/R^6$ for "small" R, $1/R^7$ for large R) are not large, they may be of significance for high-accuracy measurements in some cases. (auth)

49002 TRANSITION PROBABILITIES THEORY VERSUS EXPERIMENT. Sinanoglu, Oktay (Yale Univ., New Haven). Comments At. Mol. Phys.; 2: 73-8(Jun-Jul 1970).

New methods for both experimental and theoretical determination of atomic transition probabilities are reviewed briefly. These include the beam–foil technique for experimental measurement and a calculation method in which three types of electron correlation effects are introduced. Experimental and theoretical results, where both are available, agree. (A.G.W.)

49003 RELATIVISTIC HARTREE–FOCK–SLATER K–LM AUGER INTENSITIES: COMPARISON WITH EXPERIMENTS. Bhalla, C. P. (Kansas State Univ., Manhattan). Phys. Rev., A; 2: 722-8(Sep 1970).

The relative Auger intensities for the K–LM group with respect to the $K-L_1L_1$ line are presented as a function of the atomic number. The theoretical values are determined by the relativistic Hartree–Fock–Slater atomic model. The available experimental data are in excellent agreement with theoretical relative intensities for $Z \geq 55$. It is concluded that the relativistic effects with a realistic atomic model are as important as effects of the intermediate coupling scheme for medium Z values in the K–LM group. Additional measurements of the K–LM relative intensities for intermediate atomic numbers are needed to pinpoint the relative contributions of the relativistic model and the intermediate coupling scheme. Theoretical results are also presented for ΣK–LM ΣK–LL versus the atomic number. (auth)

49004 LAPLACE TRANSFORM WAVE FUNCTION FOR THE HYDROGEN MOLECULE ION GROUND STATE. Jakab, L. (Inst. for Atomic Physics, Cluj); Randic, M. Chem. Phys. Lett.; 6: 569-72(15 Sep 1970).

The H_2^+ ground-state energy is calculated over the range of internuclear separation from R = 0.2 to 8.0 a.u., using a Laplace-transform-type wave function. The integral transform is made on Slater-type functions with the weighting function $f(\nu, p, \alpha) =$

$\alpha^{\nu+3/2}\exp(-p\alpha/2)$. The electronic energy E = −1.0833 a.u., for the equilibrium internuclear distance (R = 2.0 a.u.) is obtained with incomplete optimization. Still lower energy is expected for larger values of the parameters ν and p. The difference between the calculated and the exact energies is not excessive over the whole range of internuclear separations considered. (auth)

49005 EXTENDED HARTREE–FOCK CALCULATIONS FOR THE GROUND STATE AND HARTREE–FOCK CALCULATIONS FOR THE FIRST EXCITED STATE OF H_2. Bowman, Joseph D. Jr. (Univ. of Wisconsin, Madison); Hirschfelder, Joseph O.; Wahl, Arnold C. J. Chem. Phys.; 53: 2743-9(1 Oct 1970).

The extended Hartree–Fock (double configuration self-consistent-field) energies and orbitals for the ground state ($^1\Sigma_g^+$) of H_2 and the Hartree–Fock energy and orbitals for the first excited state ($^3\Sigma_u^+$) of H_2 are calculated for separations ranging from the united atom to $10a_0$. The σ_g orbital obtained from the $^1\Sigma_g^+$ is almost the same as that from the $^3\Sigma_u^+$ for all separations. However, when $R < 5a_0$, the σ_u orbital from the $^3\Sigma_u^+$ is significantly more diffuse than that from the $^1\Sigma_g^+$. The correlation energy ($E_{HF} - E$) is four times larger for the $^1\Sigma_g^+$ than for the $^3\Sigma_u^+$ at the equilibrium separation, $1.4a_0$. For separations greater than $8a_0$ the two correlation energies become equal. (auth)

49006 THEORETICAL STUDY OF H_3^+ GROUND ELECTRONIC STATE SPECTROSCOPIC PROPERTIES. Beckel, Charles L. (Univ. of New Mexico, Albuquerque); Hansen III, Bertle D.; Peck, James M. J. Chem. Phys.; 53: 3681-90(1 Nov 1970).

Born–Oppenheimer and adiabatic vibrational–rotational eigenvalues are determined for the $(1s\sigma_g)^2\Sigma_g^+$ ground state of H_3^+ by a combination of Runge–Kutta and Adams–Moulton numerical techniques. These eigenvalues are believed to be more accurate than any previously reported. Dunham expansions of the potentials are used to determine Born–Oppenheimer and adiabatic spectroscopic constants; the adiabatic constants are considered to be the best set, theoretical or experimental, available for the ground state of H_3^+. The ΔG curve for this state has two points of inflection and a positive curvature tail, presumably to be associated with long-range $1/R^4$ forces in the molecular ion. The B_ν curve has a shape similar to the ΔG curve; more striking, inflection points occur at essentially the same values of the vibrational quantum number ν. The D_ν curve has a negative slope at $\nu = 0$, but rises rapidly near dissociation. The H_ν values decrease and become negative at large ν values. The sharp rise at high ν in $|h_\nu|$, like that in D_ν, is probably due to the dominance of the centrifugal reaction over the true potential at large nuclear separations R. (auth)

49007 SINGLE-CENTER CONFIGURATION-INTERACTION CALCULATIONS ON THE GROUND STATE OF H_3^+. Borkman, Raymond F. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys.; 53: 3153-60(15 Oct 1970).

Results of several single-center expansion configuration-interaction calculations are reported for the ground state of the H_3^+ molecule. A basis set of D_{3h} symmetry-adapted Slater-type orbitals is located at the center of the molecule, which forms an equilateral triangle, and the nonlinear parameters are extensively optimized. When an 85-configuration wave function is used, an energy of −1.3392 hartree, vibration frequencies of ν_1 = 3450 cm^{-1}, ν_3 = 2850 cm^{-1}, and a bond length of R_e = 1.64 bohr are obtained. The calculated energy is in error by about 4 kcal/mole compared to the estimated exact energy. The computed geometry and vibration frequencies agree to within a few percent with values reported in the literature. An analysis of the convergence of the single-center wave function is given. The Joy–Handler l^{-4} rule appears to be approximately obeyed, and the results indicate that convergence is at least as rapid for triangular H_3^+ as for linear H_3^+. The energy associated with the Hartree–Fock part of the wave function is estimated to be −1.298 hartree (99.8% of exact). This, together with a correlation energy of about 0.041 hartree (91% of exact), gives the best total energy of −1.339 hartree. (auth)

49008 INTEGRAL TRANSFORM GAUSSIAN WAVE FUNCTIONS FOR H_3^{2+} AND H_3^+. Somorjai, R. L.; Yue, C. P. (National Research Council of Canada, Ottawa). J. Chem. Phys.; 53: 1657-61(1 Sep 1970).

Wave functions obtained from a particular integral transformation of 1s Gaussian orbitals were used to calculate the ground-state energies of both H_3^{2+} (D_{3h}) and H_3^+ (D_{3h}) molecular ions. A linear combination of integral transform Gaussian-orbital–molecular-orbital (LCITGO–MO) wave function, with basis orbitals $k_\nu(qr)$ placed on the nuclei, gives for H_3^+ a total energy of −1.27724 a.u. at the equilibrium internuclear separation R_e = 1.62 a.u. The best floating function of this type gives E = −1.29367 a.u. at the internuclear separation R = 1.66 a.u. This accounts for 99.5% of the Hartree–Fock energy. The same integral transform of a total wave function, with the basis functions placed on the nuclei gives E = −1.21243 a.u. at R_e = 1.69 a.u., while letting the orbitals float improves the energy to −1.22292 a.u. (R = 1.66 a.u.). The best single-center function gives E = −1.16021 a.u. (99.4% of the s-limit energy) at R = 1.66 a.u., whereas the best single-center total transformed wave function has E = −1.13836 a.u., also at R = 1.66 a.u. The ground-state energy of the HH^+ ($D_{\infty h}$) system is E = −0.09167 a.u. (R = 1.68 a.u.) with our best nonfloating function, and becomes −0.11708 a.u. (R = 1.68 a.u.) for our floating wave function. The latter is 94.6% of the exact energy. The optimum single-center function gives E = −0.04366 a.u. at R = 1.68 a.u. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 49254.

49009 2P–2S ENERGY DIFFERENCE IN μ-MESIC HYDROGEN. Campani, E. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Lett. Nuovo Cim.; 4: 512-14(12 Sep 1970).

Contributions to the total 2P–2S splitting in μ-mesic hydrogen are calculated using a method based on the construction of an instantaneous potential through a nonrelativistic limit of the μ-p scattering amplitude; the expansion parameter is $v/c \sim \alpha$, v being the relative velocity of μ-p system. In particular, the term arising from the proton anomalous magnetic moment, and a fine structure term due to the electron vacuum polarization are reported. (L.B.S.)

49010 POSSIBLE EXISTENCE OF 2^1S_0 POSITRONIUM IN MATTER. Urbanovich, S. I. (Inst. of Physics, Minsk). Zh. Eksp. Teor. Fiz.; 59: 507-9(Aug 1970). (In Russian).

An expression is obtained for the level shift of the 2S positronium hyperfine structure as a function of the field strength between the positronium atom and the medium. An expression is also derived for the level shift of 2S positronium hyperfine structure as depending on pressure of the gas surrounding the positronium atom. A method for choosing concrete substances that may be expected not to interact with trapped atoms is proposed. The possibility of existence of such "vacuum" substances opens prospects for the search and investigation of the properties of metastable trapped atoms, in particular, of the 2^1S_0 positronium. (auth)

49011 PIONIC ATOMS. Kunselman, Arthur Raymond. Berkeley, Calif.; Univ. of California (1969). 88p. University Microfilms Order No. 70-6146.

Thesis.

The X rays produced by negative pions stopped in various targets were measured. The line shifts, line widths, and line intensities were measured in pure element targets to observe the effect of the pion–nuclear strong interaction. An optical-model analysis for the shifts and widths is presented. The line intensities in chemical compound targets were measured to observe the effects of the chemical composition of the target on the pion capture probability by the constituents. Germanium solid-state detectors were used throughout. (Diss. Abstr.)

49012 MUONIC, PIONIC, KAONIC, AND Σ^- X RAYS, ATOMIC DE-EXCITATION CASCADES, AND NUCLEAR ABSORPTION RATES IN THE LIGHT ELEMENTS. Berezin, S., (Argonne National Lab., Ill.); Burleson, G.; Eartly, D.; Roberts, A.; White, T. O. Nucl. Phys.; B16: 389-98(1970).

The yields, energies and line-widths of muonic, pionic, and kaonic x rays in Li, Be, and C are given. The data were compared with calculations of atomic cascades, including absorption from s-, p-, and d-states. Good agreement is obtained among experimental data, cascade calculations, and theoretical shell-model predictions. In all three elements, additional line structure beyond that attributable to kaonic x rays was observed when kaons were captured. In Li, two lines were observed which are provisionally attributed to x rays from Σ^- capture. The hyperons arising from previous nuclear absorption, after moderation, are themselves captured, producing x rays. Energies and yields are consistent with this interpretation. (auth)

Collision Phenomena

Refer also to abstracts 48456, 49069, and 49286.

49013 (AEC-tr-7173) INELASTIC ELECTRON SCATTERING IN NOBLE GAS ATOMS. Amus'ya, M. Ya.; Sheftel', S. I. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of Russian Preprint No. 261. 53p. Dep. CFSTI.

The differential cross sections for inelastic scattering of electrons with energies of up to 10 keV with small energy losses are investigated for atoms of Ne, Ar, Kr, and Xe. The calculation is performed in the Born approximation, and the Herman–Skillman function is used for the ejected electron. It is shown that for in-

cident-electron scattering angles of less than 6° the principal contribution to the differential cross section is made by the dipole transition $l \rightarrow l + 1$ of the atomic electron. However, the form of the cross section is largely dependent on the contribution of transitions of other multipolarities, whose behavior is studied in detail. The data obtained are in qualitative agreement with experiment. The reasons for qualitative disagreement between theory and experiment are analyzed. (auth)

49014 (BNWL-1307(Pt.2), pp 52-4) RADIATION PHYSICS. Braby, L. A.; Fleming, D. M.; Glass, W. A.; Nichols, L. L.; Roesch, W. C.; Toburen, L. H.; West, M. L.; Wilson, W. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Pacific Northwest Laboratory annual report for 1969, Vol. II, Pt. 2.

Work involving differential cross section measurements for electron ejection from 300-keV to 1.7-MeV protons on nitrogen, 1.4-MeV protons on neon, and 1.0-MeV protons on molecular hydrogen is very briefly reported. It is pointed out that experimental results were in good agreement with theory except for electrons ejected with velocities approximately equal to the incident proton velocity. No data are given here. (L.M.T.)

49015 (N-69-38564) MEASUREMENTS OF NEGATIVE ION PRODUCTION IN ATMOSPHERIC GASES. Ali, Dolores E. Oct 1969. Contract NAS2-5209. 42p. (NASA-CR-1406). CFSTI.

Two-electron capture by H^+ and He^+ in collisions with various gases was investigated. The method used to measure effective cross sections for the charge-changing reactions allows direct determination of the energy defects. Preliminary cross sections were obtained for two-electron capture by H^+ at 0.28 keV and for H^+ and He^+ at 2 keV. In addition, negative ions formed by electron bombardment of gases in the ion source were mass analyzed. The charge exchange gases used in the cross section measurements were H_2, N_2, O_2, Kr, and Xe for H^+ at 2 keV; Kr, He, H_2, N_2, and O_2 for He^+ at 2 keV; and H_2, O_2, and Xe for H^+ at 0.28 keV. The corresponding cross sections range from 10^{-19} to 10^{-17} cm^2 for H^+ at 2 keV; 10^{-22} to 10^{-21} cm^2 for He^+ at 2 keV; and 10^{-21} to 10^{-19} cm^2 for H^+ at 0.28 keV. Finally, an attempt was made to observe two-electron capture by N^+ at 2 keV; the results were inconclusive. (auth) (STAR)

49016 INTERMOLECULAR POTENTIALS FROM CROSSED-BEAM DIFFERENTIAL ELASTIC SCATTERING MEASUREMENTS. I. Ne + Ar, Ne + Kr, AND Ne + Xe. Parson, J. M.; Schafer, T. P.; Tully, F. P.; Siska, P. E.; Wong, Y. C.; Lee, Y. T. (Univ. of Chicago). J. Chem. Phys.; 53: 2123-4(1 Sep 1970).

High-resolution measurements of differential cross sections for the elastic scattering of Ne by Ar, Kr, and Xe are reported. The experiments were carried out by crossing two supersonic nozzle beams of noble gases with a rotatable universal detector. Theoretical cross sections were calculated using the JWKB method of approximating phase shifts. Low resolution cross sections were also calculated by omitting the interference term that causes the rapid oscillations. The three sets of values are shown in one figure. The fact that the observed oscillations are less pronounced than the calculated ones is attributed to imperfect energy and angular resolution. (A.G.W.)

49017 COLLISION-INDUCED DISSOCIATION OF NO^+ AND O_2^+ AT LOW KINETIC ENERGIES: EFFECTS OF INTERNAL IONIC EXCITATION. Tiernan, Thomas O.; Marcotte, Ronald E. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). J. Chem. Phys.; 53: 2107-22(1 Sep 1970).

The reactions resulting in dissociation of NO^+ and O_2^+ upon impact with various atoms and molecules were investigated in a double mass spectrometer of in-line geometry in the reactant ion kinetic energy range below 50 eV. Cross sections measured for these processes range from about 0.02 to 0.3 Å^2. The dependence of the cross section upon kinetic energy is markedly affected by the energy of the ionizing electrons that produce the reactants. At the lowest electron energy, E_e = 13 eV, kinetic-energy thresholds are observed for the production of N^+ from the NO^+/NO reaction, and for O^+ production from the O_2^+/Ar reaction, which are in excellent agreement with known adiabatic dissociation energies for the ground-state molecule ions. The production of O^+ from the NO^+/NO interaction is shown to involve a rearrangement process rather than simple collision-induced dissociation. At higher electron energies, the cross-section dependence plots exhibit structure which can be interpreted in terms of the participation of internally excited reactant ions. These results and related charge transfer experiments with NO^+ indicate that the reactant ion beam formed by 20-eV electrons includes both vibrationally excited ground-state ions and NO^+ ions in the $^1\Delta$ electronic state. Isotopic experiments in which $^{15}NO^+$ and $N^{18}O^+$, respectively, were impacted at low energies on normal NO demonstrate that the N^+ and O^+ products are derived in approximately equal amounts from the reactant ion and the reactant molecule. Products from the reaction of $N^{18}O^+$ with ^{15}NO show that the major reaction process is simple charge transfer and that the extent of isotopic scrambling in this reaction is negligible. The implications of these observations for the mechanism of the dissociation reactions are discussed. (auth)

49018 VIBRATIONALLY ADIABATIC MODEL FOR THE DYNAMICS OF $H + H_2$ SYSTEMS. Tweedale, Alan; Laidler, Keith J. (Univ. of Ottawa). J. Chem. Phys.; 53: 2045-52(1 Sep 1970).

Dynamical calculations are made for the reactions $H + H_2$, $D + D_2$, $D + H_2$, and $H + D_2$, for linear activated complexes, on the basis of the hypothesis that the zero-point vibrational energy of the reactant molecule passes smoothly into zero-point energy for the stretching vibrations of all of the intermediate complexes. By considering vibrations normal to the minimal reaction path, zero-point energies are calculated at each point along the path. Profiles for P + Z, the sum of the potential and zero-point energies, show single maxima at the activated state. Dynamical calculations for linear systems show that at high impact energies additional energy is required for crossing the P + Z barrier, arising from the centrifugal effect, but that this energy approaches zero as the impact energy is reduced towards the threshold energy. Free-energy profiles are constructed for the $H + H_2$ and $D + D_2$ systems; at higher temperatures these show double maxima, at each side of the potential-energy maximum. (auth)

49019 SEMICLASSICAL THEORY OF ATOM–DIATOM COLLISIONS: PATH INTEGRALS AND THE CLASSICAL S MATRIX. Miller, William H. (Univ. of California, Berkeley). J. Chem. Phys.; 53: 1949-59(1 Sep 1970).

The aim of this work is to show how one can use exact solutions of the classical equations of motion (numerically obtained trajectories) to construct the corresponding classical approximation to the time-independent S-matrix elements for use in quantum mechanical expressions for cross sections; it is argued that this should accurately describe many quantum effects in heavy-particle collisions. The expression for the S matrix in terms of the classical trajectory is given for systems of any number of degrees of freedom, and the matter is pursued in detail for the A + BC collision system. It is shown that within this classical limit the magnitude of an S-matrix element is explicitly determined by its phase. Constancy of total angular momentum is used throughout to reduce the 12 first-order differential equations of the A + BC system in its center of mass to eight equations. A practical method is also given (in Appendix B) for further reducing the number of coupled equations to six, the minimum number possible. (auth)

49020 ELECTRON EXCITATION CROSS SECTIONS FOR LIGHT ATOMS USING SLATER WAVE FUNCTIONS. Williamson, W. Jr. (Univ. of Toledo). J. Chem. Phys.; 53: 1944-8(1 Sep 1970).

Electron excitation cross sections are given for light atoms using Slater radial wave functions and the Born and Bethe approximations. A simple result is found for the Bethe approximation, but in the case of the Born approximation only the analytic form of the scattering amplitude is given and integration over the momentum transfer must be done. The Na ($3^2S \rightarrow 3^2P$) cross section is calculated as an example of the approximations. (auth)

49021 ANALYTICAL APPROACH TO SEMICLASSICAL INELASTIC COLLISION THEORY FOR GENERAL IMPACT PARAMETERS. Roberts, R. E. (Indiana Univ., Bloomington). J. Chem. Phys.; 53: 1941-4(1 Sep 1970).

A simple method is described for the evaluation of classical trajectory integrals that play an important role in semiclassical collision theory. The results for a Lennard–Jones potential are compared with the exact results of Bernstein and Kramer and then are applied to an optical analysis of glory quenching for low-energy Li–HBr collisions. Calculations and comparison with exact results are also presented for an exponential interaction. (auth)

49022 SEMICLASSICAL TREATMENT OF VIBRATIONALLY INELASTIC COLLISIONS. Roberts, R. E. (Indiana Univ., Bloomington). J. Chem. Phys.; 53: 1937-40(1 Sep 1970).

A semiclassical theory for inelastic collisions is used to calculate direct and multiple transition probabilities for the collinear collision of an atom with a harmonic oscillator. The method is based upon a single optimal choice of the effective interaction potential for the entrance and exit scattering channels. In light of the simplicity of this approach as well as the agreement with exact quantum-mechanical results for this model problem, extensions of the theory to more complex inelastic processes are possible. (auth)

49023 RELATIVISTIC CALCULATION OF ANOMALOUS SCATTERING FACTORS FOR X RAYS. Cromer, Don T.; Liber-

man, David (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 53: 1891-8(1 Sep 1970).

Anomalous scattering factors $\Delta f'$ and $\Delta f''$ were calculated relativistically for Cr, Fe, Cu, Mo, and Ag K_α radiations from the atoms Li through Cf. An interpolation scheme for other wavelengths is included in a separate report. Relativistic calculations of the photoelectric cross section were made and the integral for the principal contribution to $\Delta f'$ was evaluated numerically without approximation to the form of the cross section-vs-energy curve, as has been done in previous calculations. Many of the results are significantly different from previous calculations. Where experimental values exist, agreement for $\Delta f''$ is improved. For the rare gases, except for xenon, agreement between $\Delta f'$ and experiment is improved. Because of the more rigorous evaluation of $\Delta f'$ from cross-section information, it is presumed that the present $\Delta f'$ values are more accurate than previous calculated values. Calculated mass absorption coefficients for the elements are included as incidental information. (auth)

49024 INELASTIC ENERGY-LOSS STRUCTURE IN NON-VIOLENT HEAVY-ATOM COLLISIONS. Bierman, D. J.; Turkenburg, W. C. (Instituut voor Atoom-en Molecuulfysica, Amsterdam). Phys. Rev. Lett.; 25: 633-5(7 Sep 1970).

Inelastic energy-loss measurements for small-angle scattering in $Ne^+ \rightarrow Ne$ and $Ar^+ \rightarrow Ar$ collisions are reported. The resulting energy-loss spectra display a structure that may be explained in terms of curve crossing and preionization. (auth)

49025 CROSS SECTIONS FOR THE ELECTRON-IMPACT BROADENING OF 2P LEVELS OF HYDROGEN AND IONIZED HELIUM. Griem, Hans R. (Univ. of Maryland, College Park). Comments At. Mol. Phys.; 2: 53-8(Jun-Jul 1970).

A method for determination of the parameters C_1 and C_2 found in equations for total cross sections for the scattering of electrons by the 2P states of hydrogen or ionized helium is described briefly. Results based on this method are compared with results of other calculations. (A.G.W.)

49026 FRAME TRANSFORMATIONS IN ELECTRON-MOLECULE COLLISIONS. Fano, Ugo (Univ. of Chicago). Comments At. Mol. Phys.; 2: 47-52(Jun-Jul 1970).

Two alternative frames of reference, the body frame and the laboratory frame, used in calculations of electron-molecule collisions are considered. The applicability of each is discussed in terms of a dissociated system and a complex; the system is regarded as dissociated when the distance (r) of at least one electron from the center of mass exceeds 5 or 10 Å and as a complex when the electron is contained within such a radius. The essential feature of the present analysis is initial calculation of scattering eigenfunctions within the complex, followed by expansion in the representation of the dissociated system and by further outward integration to $r \rightarrow \infty$. (A.G.W.)

49027 PREFERENTIAL ORIENTATIONS FOR VIBRATIONAL-TRANSLATIONAL ENERGY TRANSFER. Gianturco, F. A.; Lamanna, U. (Istituto di Chimica Fisica, Pisa, Italy). Chem. Phys. Lett.; 6: 326-30(15 Aug 1970).

An approximate angle-dependent potential is suggested for atom-diatom inelastic collisions in which vibrational excitations take place. Calculations are performed via a partial wave expansion of the total wave function and in the close-coupling treatment. Results for some model cases are examined and the approximations discussed. (auth)

49028 EXPERIMENTAL CROSS SECTIONS FOR INDIVIDUAL VIBRATIONAL QUANTUM TRANSITIONS IN LOW-ENERGY CENTRAL COLLISIONS OF Li^+ WITH H_2. Held, W.-D. (Univ., Goteborg); Schoettler, J.; Toennies, J. P. Chem. Phys. Lett.; 6: 304-6(15 Aug 1970).

The excitation of individual vibrational states in central collisions of monoenergetic Li^+ ions on H_2 molecules in the ground vibrational state was observed at cms energies of 2.28, 4.50, and 6.73 eV using a time-of-flight method described earlier. The time-of-flight spectra were fitted by a least squares technique to yield relative excitation probabilities and absolute differential cross sections for the transitions $n = 0 \rightarrow n = 1$, $n = 0 \rightarrow n = 2$, up to $n = 0 \rightarrow n = 9$. The relative probabilities agree suprisingly well with the one-dimensional quantum mechanical calculations of Secrest and Johnson. (auth)

49029 SCATTERING OF LITHIUM BY A SERIES OF MOLECULES. IV. MISCELLANEOUS MOLECULES. Rothe, Erhard W. (Wayne State Univ., Detroit); Helbing, Reinhard K. B. J. Chem. Phys.; 53: 3501-5(15 Sep 1970).

This is the final paper in a series that describes measurements of the velocity dependence of the total cross section for the scattering of lithium-7 by a series of molecules. The experiments are similar to the previous measurements of the scattering from 52 molecules. The molecules here consist of seven triatomics, five tetra-atomics, and nine miscellaneous organics. Potential parameters are obtained. Some qualitative correlations of the quenching of the glory amplitudes are made, but no real theoretical explanation is attempted. (auth)

49030 EXACT CLASSICAL CALCULATIONS ON COLLISIONAL ENERGY TRANSFER TO DIATOMIC MOLECULES WITH A ROTATIONAL AND A VIBRATIONAL DEGREE OF FREEDOM. Kelley, J. Daniel (Brookhaven National Lab., Upton, N. Y. McDonnell Douglas Corp., St. Louis); Wolfsberg, Max. J. Chem. Phys.; 53: 2967-77(1 Oct 1970).

Exact classical calculations are carried out on energy transfer from the translational degree of freedom to the vibrational and rotational degrees of freedom in nonreactive atom-diatomic-molecule collisions. The diatomic molecule is either a harmonic or a Morse oscillator and the interaction potential is exponentially repulsive in the interatomic distances. The exact calculations are used to test the validity of a number of approximations that have been applied in theoretical treatments of this type of system. It is shown that the dynamic interaction between molecular rotational and vibrational motion during collision can introduce important differences between noncollinear and collinear collisions; as a result, great care must be exercised in drawing conclusions from calculations on collinear systems. (auth)

49031 REACTIVE SCATTERING: A SIMPLE THREE-BODY MODEL. Locker, David J.; Wilson, David J. (Vanderbilt Univ., Nashville). J. Chem. Phys.; 53: 2858-68(1 Oct 1970).

A simple model is created, which can be solved for the change in population probabilities of reactive and nonreactive channels due to molecular collision. The system consists of an atom collinearly colliding with a diatomic molecule. Both the reactant molecule and the product molecule are chosen to be square well oscillators. The possibility of the formation of three free particles is forbidden. Matching wave functions at the various boundaries in an orthogonal function sense permits the calculation of a scattering matrix. The effects of varying the parameters of the model are then examined: relative translational energy, atomic masses, molecular orientation, potential energy barrier height, and passage widths. (auth)

49032 DISSOCIATIVE ATTACHMENT IN CO AND FORMATION OF C^-. Stamatovic, A.; Schulz, G. J. (Yale Univ., New Haven). J. Chem. Phys.; 53: 2663-7(1 Oct 1970).

The negative ions O^- and C^- produced by dissociative attachment of electrons in CO are measured using a quadrupole mass spectrometer. A trochoidal monochromator is used to give an electron energy distribution of about 0.07 eV. Within this resolution, the O^- ion current exhibits a vertical onset at threshold and structure is observed at higher energies. The cross section of the production of C^- shows an onset at 10.20 ± 0.04 eV, a peak at 10.4 eV, and a second peak at 10.9 eV. The cross section at the first C^- peak is found to be smaller than the peak cross section for O^- production by a factor of $3300 \pm 20\%$. Using the previously determined value for the O^- cross section (2×10^{-17} cm^2) the peak cross section for C^- formation is about 6×10^{-23} cm^2. (auth)

49033 ION-ION RECOMBINATION TOTAL CROSS SECTIONS: ATOMIC SPECIES. Olson, Ronald E.; Peterson, James R.; Moseley, John (Stanford Research Inst., Menlo Park, Calif.). J. Chem. Phys.; 53: 3391-7(1 Nov 1970).

A multistate Landau-Zener method is set up for the calculation of atomic ion-ion mutual neutralization total cross sections. The results of the calculations are compared with experimental results for $O^+ + O^-$, $N^+ + O^-$, $He^+ + D^-$, $He^+ + H^-$, and $H^+ + H^-$. The energy range scanned depends on the system but varies between about 0.1 and 10,000 eV. The agreement between theory and experiment is usually within a factor of 2. (auth)

49034 CLASSICAL S MATRIX: NUMERICAL APPLICATION TO INELASTIC COLLISIONS. Miller, William H. (Univ. of California, Berkeley). J. Chem. Phys.; 53: 3578-87(1 Nov 1970).

A previously developed semiclassical theory of molecular collisions based on exact classical mechanics is applied to the linear atom-diatom collision (vibrational excitation). Classical, semiclassical, and uniform semiclassical results for individual vibrational transition probabilities corresponding to the H_2 + He system are presented and compared to the exact quantum mechanical results of Secrest and Johnson. The purely classical results (the classical limit of the exact quantum mechanical transition probability) are seen to be accurate only in an average sense; the

semiclassical and uniform semiclassical results, which contain interference effects omitted by the classical treatment, are in excellent agreement (within a few percent) with the exact quantum transition probabilities. An integral representation for the S-matrix elements is also developed, which, although it involves only classical quantities, appears to have a region of validity beyond that of the semiclassical or uniform semiclassical expressions themselves. The general conclusion seems to be that the dynamics of these inelastic collisions are basically classical, with all quantum mechanical structure being of a rather simple interference nature. (auth)

49035 GENERAL PROOF OF LASSETTRE'S THEOREM. Bonham, R. A. (Tokyo Univ. Indiana Univ., Bloomington). J. Chem. Phys.; 53: 3726-7(1 Nov 1970).

A general proof of Lassettre's theorem—the limit as K_{0n} approaches zero of K_{0n} times the exact scattering amplitude is equal to the same limit of K_{0n} times the first Born amplitude including exchange where $\hbar K_{0n}$ is the inelastic momentum transfer for excitation of the target system between the states 0 and n—is given. (auth)

49036 ROLE OF INNER SHELLS IN CHARGE EXCHANGE BETWEEN PROTONS AND MULTIELECTRON ATOMS. Vinogradov, A. V.; Shevel'ko, V. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 59: 593-601(Aug 1970). (In Russian).

Charge exchange between protons and complex atoms involving formation of hydrogen atoms in various n, l states is considered. It is shown that at sufficiently high collision energies in such reactions, allowance should be made for electron capture from the inner shells. Concrete calculations are presented for the cross sections for formation of highly excited H atoms during charge exchange of protons with alkali metal atoms. Calculations are also presented for the total cross sections for charge exchange with Cs and Ar atoms. The results of the calculations are in agreement with the experimental data. (auth)

Atomic Theory

Refer also to abstracts 49292 and 49297.

49037 EXPECTATION VALUES IN ONE- AND TWO-ELECTRON ATOMIC SYSTEMS. Tsapline, B. (Battelle Inst., Geneva). Chem. Phys. Lett.; 6: 596-600(15 Sep 1970).

Some inequalities are derived for electronic expectation values in position and momentum spaces from theoretical considerations including the Schwarz inequality. The influence of the type of the basis (usual exponential orbitals or gaussian orbitals) is analyzed. Numerical applications are given for hydrogen and helium. (auth)

49038 INTEGRAL TRANSFORM TRIAL FUNCTION FOR HELIUM-LIKE SYSTEMS. Bishop, David M.; Schneider, Barbara E. (Univ. of Ottawa). Chem. Phys. Lett.; 6: 566-8 (15 Sep 1970).

The one-dimensional Laplace transform of exp (-rx): $f(r) = L\{F(x)\} = \int_0^\infty \exp(-rx)F(x)dx$ can be used to generate functions that could be useful as basis sets for atomic and molecular calculations. A particular choice of the weighting function, F(x), leads to functions of the form $\phi(r) = (q\sqrt{r})^p K_p(q\sqrt{r})$, where $K_p(x)$ are modified Bessel functions of the second kind. These functions were used as basis functions for the helium isoelectronic series and accounted for 99.95% (H^-), 99.98% (He), and 99.99% (Li^+) of the Hartree-Fock energy. (auth)

49039 SCF RELATIVISTIC HARTREE-FOCK CALCULATIONS ON THE SUPERHEAVY ELEMENTS 118 TO 131. Mann, Joseph B. (Los Alamos Scientific Lab., N. Mex.); Waber, James T. J. Chem. Phys.; 53: 2397-2406(15 Sep 1970).

The energies of a number of configurations of the elements with atomic numbers 118 to 131 were computed by means of the relativistic Hartree-Fock method to establish the probable ground states. The series of elements beginning at 121 differ markedly from the lanthanide and actinide series because spin-orbit and direct relativistic effects cause the $8p_{\frac{1}{2}}$ electron states to be partially filled before the $7d_{\frac{3}{2}}$ states. The inner shell of 5g electrons begins to fill at element 125. The Breit magnetic interaction energy is calculated by a perturbation method; an approximate correlation energy correction is included. Isotopic mass effects on the atom total energy and on the electron eigenvalues are discussed. (auth)

Cosmic Radiation

Refer also to abstracts 48317, 48955, 48977, 48978, 49060, 49229, 49305, and 49405.

49040 SPATIAL DISTRIBUTION OF THE DIFFUSE COMPONENT OF COSMIC X RAYS. Schwartz, Daniel Alan. San Diego, Calif.; Univ. of California (1969). 128p. University Microfilms Order No. 70-8650.

Thesis.

The Third Orbiting Solar Observatory (OSO-III) carried an x-ray detector collimated to a 23° full width at half maximum aperture, and sensitive to photons between 7.7 and 210 keV. The data were analyzed in five logarithmically spaced energy channels between 7.7 and 110 keV to study the spectrum and angular distribution of the diffuse component of cosmic x rays. The term "diffuse" is used, although this experiment cannot eliminate the possibility that the x rays actually emanate from numerous discrete sources. Sources of background subtracted from the raw count rates are phototube noise, counts due to cosmic-ray induced γ rays, and counts due to γ rays associated with the β-decay of ^{24}Na. At 10 keV about 98% of the counts represent diffuse x-rays; at 85 keV only about 25% remain after background correction. The programs eliminate a large portion of the data because of possible contamination by charged particles, albedo x rays, solar x rays, and x rays from the discrete galactic sources. A program compiles counts within 30° of the galactic poles to study the energy spectrum. Considering photon counting statistics and estimated errors in the background correction, the four lowest channels have standard deviations from 1.5 to 3%, and 14% for the 65- to 110-keV channel. A power law with a constant index cannot represent the data. Considering the detector efficiency and resolution, the lowest three channels fit a power law of index 1.7 ± 0.1 with a normalization constant 16.7 photons $(keV)^{0.7}$ $(cm^2\ sec\ ster)^{-1}$. A discontinuity of 0.6 to 1.5 in the index between 32 and 46 keV can then fit the two highest channels. (TSS) (Diss. Abstr. Int., B)

49041 COSMIC-RAY ANISTROPY IN INTERPLANETARY SPACE. Ericksen, Jacqueline Hope. Albuquerque, N. Mex.; Univ. of New Mexico (1969). 160p. University Microfilms Order No. 70-10,117.

Thesis.

The solar diurnal variation of cosmic-ray intensity results from an interaction of cosmic rays with the corotating spiral interplanetary magnetic field. Changing interplanetary conditions might therefore be reflected in the diurnal variation. The dependences of the quiet-day solar diurnal variation on the general level of solar activity and on the interplanetary sector structure are investigated. It is found that the amplitude of the solar diurnal variation as recorded by the Embudo and Bolivia multidirectional underground muon telescopes is significantly smaller near solar minimum (1965) as compared to solar maximum (1968). This amplitude dependence is associated with a change in the maximum primary rigidity that can be modulated by the corotating interplanetary magnetic field. It is found that this maximum rigidity was as low as 40 GV in 1965, and had risen to approximately 90 GV in 1968. It is shown, in addition, that the solar diurnal variation recorded by underground telescopes is contributed in part by a Compton-Getting effect, which results from the motion of the Earth through the interplanetary medium as it orbits the sun. It is found that the solar diurnal variation monitored by underground telescopes is sensitive to the interplanetary sector structure, displaying a dependence of phase on the sense of the interplanetary magnetic field (predominantly into, or out of, the sun). It is shown that this phase dependence can arise from a cosmic-ray anisotropy which is normal to the ecliptic plane, and that it is possible that the observed sector structure dependence of the solar diurnal variation and sidereal diurnal variations reported by others can arise from the same source. The importance of underground measurement is emphasized, because the investigations described would have been impossible through the use of neutron monitors, which respond to much lower rigidities. (TSS) (Diss. Abstr. Int., B)

49042 STUDY OF THE ORIGIN AND PROPAGATION OF GALACTIC COSMIC-RAY ELECTRONS. Berkey, Gordon Bruce. Lafayette, Ind.; Purdue Univ. (1969). 118p. University Microfilms Order No. 70-8857.

Thesis.

The modulation of the energy spectrum of cosmic-ray electrons as they propagate in interstellar space is studied. The effects of spatial propagation, energy loss, boundary conditions, and the spatial distribution and energy spectrum of the electrons injected into interstellar space by the sources are all taken into account. Two models for spatial propagation are considered: isotropic diffusion and convection-diffusion, in which particle motion parallel to the disk plane is characterized by diffusion, while the particles are transported perpendicular to the disk by convection, caused by the outward expansion of the field lines. Parameters in both models are chosen to be consistent with the amount of material traversed by cosmic-ray nuclei, the near-isotropy of the cosmic-ray velocity distribution, and the existence of a Galactic radio halo. Examples are worked out for several source distributions. It is

shown that the distribution of high-energy electrons is determined by the source distribution, rather than the properties of the confinement region (i.e., the propagation model). In order to illustrate how one can use the observable quantities (the electron spectrum and positron fraction at Earth, and the Galactic background radio and γ radiation) to determine the properties of the injection spectrum, the construction of a model of primary cosmic-ray electron sources is considered. It is found that a combination of a source with a disk distribution and a source concentrated at the galactic center may be necessary to explain the observed Galactic γ rays. It is pointed out that precise measurements of the positron spectrum and the background Galactic γ radiation are crucial to the selection of a model. The former would specify the spatial propagation model, since the positron production spectrum is well known. The latter, if the γ rays are in fact produced by inverse Compton scattering of ambient photons by electrons, would reveal the distribution of the primary electron sources. (Diss. Abstr. Int., B)

49043 NATURE OF THE PRIMARY COSMIC RADIATION. Powell, C. F. (Univ. of Bristol, Eng.). pp 715-28 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The development of the understanding of cosmic radiation is reviewed. Experiments carried out through the years to study these radiations are discussed. It is shown that the spectrum of the dominant nuclear component of the primary cosmic radiation contains elements extending into the transuranium region. (M.C.G.)

49044 EVIDENCE FOR AN ANISOTROPY IN THE COSMIC RAY SIGNAL. Ryan, D. F. (State University Coll. of Arts and Science, Plattsburgh, N. Y.). Nature (London); 227: 1120-1(12 Sep 1970).

It is stated that anisotropies in cosmic-ray signals could provide information regarding the origin of cosmic rays. Evidence is reported for an anisotropy centered around 0900 hr sidereal time and between +30° and +60° declination. The observations were made with a cosmic-ray telescope 30 miles south of Plattsburgh (45°N, 74°W, 400 ft above sea level), and the data consisted of the clock times of muon events in a liquid scintillator, collected between Aug. 1967 and June 1968 and from Dec. 1968 to June 1969. The experimental work was concerned with muons of moderate energy (<200 MeV) that appeared and decayed in the detector, which was located 120 ft below ground level. The technique adopted is described in detail. The site of the equipment (an abandoned missile site) provided a collimator 180 ft deep and 50 ft diameter. From Aug. 1967 to June 1968, 50 gallons of liquid scintillator were used as the detector target, and 80 gallons from Dec. 1968 to June 1969. Two independent runs were made under somewhat different detector configurations, and moderate-energy muons which appeared and decayed in the detector, and that satisfied the anti-coincidence requirement, were presumed to have been produced by a neutral particle in the cosmic rays. More than 8,000 muon-like events were observed, the signal rates for the two runs being, on the average, 0.75 and 1.75 per hour. The number of stopping muons in the detector from ordinary cosmic rays averaged approximately 1.5 and 3.0 per minute for the two detector configurations. A peak of 3.7 standard deviations was observed between 0830 hr and 1000 hr local sidereal time in the earlier observations, and the probability of such a peak occurring by chance is less than one in four thousand. In the run beginning in Dec. 1968 there was a peak of 2.3 standard deviations between 0915 and 1045 hr local sidereal time. It was estimated that about one-third of the events were due to leakage muons from the cosmic-ray background and could have been responsible for the sidereal effect. The observed muon signal does indicate a strong dependence on sidereal time and the effect has persisted in the same area of the sky for two consecutive years. The reality of the anisotropy therefore seems well established. An attempt is being made to determine whether the muons are leakage muons or are produced in the detector by a neutral particle in the cosmic rays. (UK)

49045 RADIO PULSES FROM EXTENSIVE AIR SHOWERS. Allan, H. R. (Imperial Coll. of Science and Tech. London); Clay, R. W.; Jones, J. K. Nature (London); 227: 1116-18 (12 Sep 1970).

Radio pulses associated with extensive air showers have been detected by many investigators during recent years, but quantitative information is still sparse. In the studies described a 1:1 relationship was obtained between radio-pulse amplitude and shower parameters given by particle detectors. Some scatter remained, but this could reasonably be attributed to the known uncertainties in the particle parameters. Improvements in measurements have been due, chiefly, to the adoption of 55 MHz as the principal measuring frequency. At this frequency, background pulses were reduced to a minimum, and an air shower pulse could be identified unequivocally if it had an amplitude appreciably larger than the thermal background. Measurements were made during the night to avoid man-made interference. Full details are given of the equipment and technique adopted. Over a period of six months 49 radio showers were identified by the pulses they produced in the 55-MHz receivers. The principal interest was to relate the amplitude of the frequency component of the total electric-field vector to the relevant parameters of the air shower as measured by the particle array. Radiation mechanisms are discussed, and it is assumed that the radiation is due wholly to geomagnetic charge separation. The dependence of the frequency component on the primary energy is considered in the context of the theory of coherent radiation. The showers considered had energies E_p between 10^{17} and 10^{19} eV, apart from a rare shower of $\sim 1.5 \times 10^{19}$ eV. The effect of changes in zenith angle on the radio pulse amplitude is discussed. The discussions and conclusions reached are summarized in a single equation. (UK)

49046 ATMOSPHERIC TEMPERATURE EFFECTS UPON VARIOUS MEAN CHARACTERISTICS OF EXTENSIVE SHOWERS. Dedenko, L. G. Kosm. Luchi; No. 10, 60-1(1969). (In Russian).

The mean values of the extensive air shower characteristics were computed for different temperatures of the isothermic atmosphere for different observation levels. The temperature effects in calculations of the muon number counts are analyzed. (auth) (Meteorol. Geoastrophys. Abstr.)

49047 SOLAR-DIURNAL VARIATIONS OF COSMIC RAYS FROM THE MAXIMUM TO THE MINIMUM OF SOLAR ACTIVITY. Dorman, L. I.; Kolomeets, E. V. Kosm. Luchi; No. 9, 108(1968). (In Russian).

The planetary distribution and energy dependence of the first and second harmonics of the solar diurnal variation of cosmic rays in the quiet and disturbed periods are analyzed according to data of the world network of neutron monitors for 1957–1964, i.e., for the period from the maximum to the minimum of solar activity. A comparison is made with the results of other authors. The work shows that the anisotropy of cosmic rays is a sensitive characteristic of the changing conditions in interplanetary space. On the basis of the data obtained, a critical analysis is conducted of the mechanisms, much discussed in the literature, that cause anisotropy of the galactic cosmic rays in the solar system. A model of appearance of solar diurnal variation of cosmic rays is developed on the basis of the theory of anisotropic diffusion of particles on the moving irregularities of the interplanetary magnetic field in the presence of the regular field with different directions of the field with force lines in the form of the Archimedes spirals. It is shown that the experimental data are best correlated with this model qualitatively and do not contradict it quantitatively. (auth) (Meteorol. Geoastrophys. Abstr.)

Direct Energy Conversion

49048 (UCRL-72349) SOME ECONOMIC ASPECTS OF POWER CONVERSION FOR FUSION REACTORS. Mohr, P. B. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Sep 1970. 8p. (CONF-700912-3). Dep. CFSTI.

From 5th Annual Intersociety Energy Conversion Engineering Conference, Las Vegas, Nevada.

It is considered how increased conversion efficiency made possible by advances in materials, direct conversion and thermodynamic technology may be utilized to offset both fixed and variable costs. Thermonuclear reactors produce power in the form of both neutral and energetic charged particles. Using present power costs as a base, one finds thermodynamic conversion of the energy of neutral particles to be adequate to support internal power requirements as great as 25% of the fusion power, providing capital cost per marketable kilowatt for the entire system is not more than one and one-half to two times that of current fossil fuel systems. On the same basis, the direct conversion of energetic charged particles at high (>90%) efficiency would allow circulation of internal power approaching the same order as the fusion power. For lesser internal power requirements, high injection and recovery efficiency would allow normalized capital costs from two to three times present values, or, alternatively, power costs could be substantially reduced. (auth)

49049 THREE-DIMENSIONAL ANALYSIS OF AN MHD GENERATOR. Rao, K. R. (Univ. of Texas, Arlington); Krish-

naiah, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Power App. Syst.; PAS-89: 1237-41(Jul-Aug 1970).

An MHD generator having a uniform rectangular duct is analyzed for a three-dimensional flow. Expressions in closed form are obtained for the fluid velocity, induced electromagnetic fields, open-circuit voltage, power output, power input, efficiency, etc. These quantities are computed for typical values of dimensions, temperature, and velocity at the center of the generator. (auth)

49050 INFLUENCE OF THERMAL INTERFACE LAYER IN A CHANNEL ON MEASUREMENTS OF FLOWING PLASMA TEMPERATURE BY METHOD OF REVERSAL OF SPECTRUM. Vasil'eva, I. A.; Kirillov, V. V.; Nefedov, A. P. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp.; 7: 495-501 (May-Jun 1969). (In Russian).

The temperature of combustion products in the channel of an MHD generator was measured by a method of reversal of sodium D lines. Calculated optical temperatures were lower than the temperatures in the center of the flow. It was observed that the temperature difference increased with the increase of sodium atom concentration in the combustion products. The D lines of sodium in the channel were calculated, and the results obtained were used for determining the difference between optical and center flow temperatures. (R.V.J.)

49051 SELECTION OF OPTIMUM PARAMETERS FOR LIQUID-METAL MHD GENERATOR. Stepanchuk, V. F.; Saltanov, G. A.; Tsiklauri, G. V. (Moscow Inst. of Power Engineering). Teplofiz. Vys. Temp.; 7: 502-7(May-Jun 1969). (In Russian).

Optimization of working parameters for liquid-metal MHD-generators is studied, considering uneven condensation processes at the diffuser entrance. The parameters, which are presented in tabular and graphical forms, are analyzed. (R.V.J.)

49052 EFFECTS OF PROPERTIES OF WORKING MATERIALS ON THERMODYNAMIC PARAMETERS OF MHD GENERATORS. Tetel'baum, S. D. (Odessa Technological Inst.). Teplofiz. Vys. Temp.; 7: 579-81(May-Jun 1969). (In Russian).

An analysis is made of the influence of various working materials (inert gases, combustion products, gaseous nuclear fuels, alkali metals, etc.) on thermodynamic parameters of MHD generators operating with the simplest Brayton gas cycle with regeneration in the low-temperature part of the cycle and utilization of heat in high-temperature zones. (R.V.J.)

49053 EXPANSION OF THE ANODE REGION AND VOLT-AMPERE CHARACTERISTICS OF A THERMIONIC CONVERTER IN A TRANSVERSE MAGNETIC FIELD. Kuznetsov, V. I.; Morozov, Yu. G.; Ender, A. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 495-6(Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 642-4(Mar 1970).

The equations for solving the volt-ampere characteristics in a transverse magnetic field are described. Corrections to earlier calculations (A. Ya. Ender, Zh. Tekh. Fiz., 40: 551(1970)) are presented. (M.O.W.)

49054 COLLISIONLESS THERMIONIC CONVERTER IN A TRANSVERSE MAGNETIC FIELD. Ender, A. Ya. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 426-33(Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 551-60(Mar 1970).

In the operation of a thermionic converter in the collisionless regime there are large losses due to the magnetic field. This problem was investigated earlier and it was assumed that there is a constant electric field in the gap. In the present work, the plasma in an ideal collisionless converter is investigated in the overcompensated regime in the presence of a transverse magnetic field. Volt-ampere characteristics are plotted for various values of the magnetic field and the compensation parameter γ, the ratio of the ion to electron density at the cathode. The results make it possible to determine experimentally the degree of ionization in the thermionic converter. (auth)

49055 EFFECT OF A TRANSVERSE MAGNETIC FIELD ON THE VOLT-AMPERE CHARACTERISTICS OF A COLLISIONLESS THERMIONIC CONVERTER. Babanin, V. I.; Barabash, M. B.; Gaido, G. K.; Dunaev, Yu. A.; Kravinskii, Yu. G.; Mustafaev, A. S.; Spirdonov, G. A.; Sitnov, V. I.; Tashbaev, N. M.; Ender, A. Ya. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 434-7 (Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 561-6(Mar 1970).

An experimental investigation was made of the influence of a transverse magnetic field on the current of a collisionless thermionic converter (TC). Over a wide range of cathode temperatures and Ba and Ba + Cs pressures an increase in the transverse magnetic field leads to a reduction of the saturation current of the converter. These experimental results are in good qualitative agreement with other theoretical conclusions. In a transverse magnetic field the current in the volt-ampere characteristics does not saturate with positive anode potential, but continues to rise. This effect is more clearly pronounced at low currents. A current increase can arise from a number of causes, one being the expansion of the anode region. (auth)

49056 RADIAL DISTRIBUTION OF PLASMA PARAMETERS IN A PLANE THERMIONIC CONVERTER. Dyuzhev, G. A.; Startsev, E. A.; Yur'ev, V. G. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 323-5(Aug 1970).

Translated from Zh. Tekh. Fiz.; 40: 426-8(Feb 1970).

The investigations were made on two types of devices: with no shields on the electrodes and with planar circular screens of sapphire on the cathode and anode. The gap between the shields and the electrodes did not exceed 0.05 mm. There was a cylindrical probe in the devices of diameter 100 μ and length 1 mm, the axis of which was perpendicular to the x and y axes and which could be moved parallel to the y axis by means of a syphon bellows. The cathode and the anode, rigidly connected together, could be shifted along the x axis. The distribution of the parameters of the plasma both along the x axis and the y axis was investigated. The electron temperature T_e was determined from the slope of the semilogarithmic probe characteristic, and the density from the ion saturation current. (M.O.W.)

49057 ION-ACOUSTIC OSCILLATIONS IN A PLASMA DIODE. Zherebtsov, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 444-7(Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 575-80(Mar 1970).

The stability of low-frequency oscillations in a plasma diode is investigated in the absence of collisions. The linearized hydrodynamic equations for the electron and ion fluxes at the electrodes are used. When the potential jump at the cathode retards the electrons and the potential jump at the anode retards the ions, it is shown that ion-acoustic oscillations can be excited in the diode. Expressions for the frequencies, growth rates, and wavelengths are derived. (auth)

Fluid Physics

Refer also to abstracts 49163 and 50201.

49058 (AD-703182) ON COSMIC HYDROMAGNETIC DYNAMO THEORY. McDonald, Keith Leon (Earth Sciences Labs., Boulder, Colo.). Dec 1969. 94p. (ESL-7; ERL-147). GPO $1.00.

Hydromagnetic phenomena associated with astrophysical bodies, with particular emphasis being given to the Earth's core are treated. The transformation, by the method of spherical harmonic expansion, for compressible media, of the amplification equation, the Navier-Stokes equation, and the thermal energy transport equation are carried out, and an analysis is made of the resulting partial differential equations that define the scaloidal, poloidal, and toroidal sets of radial functions. General mathematical methods of transforming arbitrary differential equations are discussed. (auth) (USGRDR)

49059 TRANSIENT SOLUTION FOR STOKES' SECOND PROBLEM IN MAGNETOHYDRODYNAMICS. Rudraiah, N. (Visvesvaraya Coll. of Engineering, Bangalore, India). Phys. Fluids; 13: 2616-19(Oct 1970).

A closed form solution for the transient solution of Stokes' second problem is given in terms of exponential and error functions of a complex argument. The transient dies out rapidly with an increasing Hartmann-type number m as distance from the plate increases. (auth)

49060 THEORETICAL MAGNETOFLUIDDYNAMICS. Cabannes, Henri. Applied Mathematics and Mechanics, An International Series of Monographs. Volume 13. New York; Academic Press Inc. (1970). 243p. $12.50.

Translated by Maurice Holt.

An exposition of the theory of motion of compressible fluids under the influence of external or self induced magnetic fields is presented. The subject is treated from the macroscopic or continuum point of view and can be regarded as a generalization of the theory of nonconducting compressible fluids when electromagnetic fields are included. The subject is developed from first principles beginning with a complete derivation of equations of motion and shock-wave equations. Later chapters deal with small disturbance theory (analogous to the linearized theory of classical high-speed flow), properties of MHD shocks, one-dimensional flows, and

aerodynamic problems (including viscous effects) treated both from the exact and linearized points of view. (M.H.R.)

49061 CONVECTIVE MAGNETOHYDRODYNAMIC FLOW IN A VERTICAL CHANNEL. Yu, C. P. (State Univ. of New York, Buffalo). Appl. Sci. Res. (The Hague); 22: 127-40(Apr 1970).

An analysis is presented for the combined forced and free convective magnetohydrodynamic flow in a vertical, finite rectangular channel that is subjected simultaneously to a pressure gradient and a temperature gradient. Exact solutions are found for electrically nonconducting channel walls and perfectly conducting walls. In particular, the case of heating from below is examined and discussed. (auth)

49062 GENERAL SOLUTION TO UNSTEADY, COUPLED MAGNETOHYDRODYNAMIC COUETTE FLOW. Charles, M.; Smith, Ph. R. (New Mexico State Univ., Las Cruces). Appl. Sci. Res. (The Hague); 22: 44-59(Feb 1970).

A general solution to nonsteady coupled magnetohydrodynamic plane Couette flow by the method of Fourier series expansion is presented. Two particular examples of the utility of the solution are included: (1) an impulsive start of the wall, and (2) a wall velocity proportional to $(1 - \exp(-\alpha t))$. For the case of an impulsive start of the wall it is found that flow is apparently accelerated by the presence of the magnetic field, a situation opposite to that which occurs when no induced magnetic field is allowed. (auth)

49063 MAGNETOAERODYNAMIC BOUNDARY LAYER FLOW WITH PRESSURE GRADIENT AND SEPARATION. Eggenberger, A. J.; Hughes, W. F. (Carnegie-Mellon Univ., Pittsburgh). Appl. Sci. Res. (The Hague); 22: 60-77(Feb 1970).

The large interaction parameter magnetoaerodynamic boundary layer associated with the free stream flow of a conducting fluid is considered over an infinitely long circular insulator cylinder with the applied magnetic field normal to the distant free stream flow. The investigation is conducted in two parts; a theoretical solution of the associated boundary layer equations and a qualitative experimental investigation to allow visualization of flow separation caused by the magnetic field. The general integral formulation of Galerkin-Kantorovich-Dorodnitsyn is used to determine the boundary layer thickness, momentum thickness, displacement thickness, approximate separation point, and velocity profiles. (auth)

49064 LOW-SPEED MHD COUETTE FLOW OF A SLIGHTLY RAREFIED AND ELECTRICALLY CONDUCTING GAS. Tan, C. W. (Cooper Union for the Advancement of Science and Art, New York). Appl. Sci. Res. (The Hague); 22: 201-22(May 1970).

The effects of an applied magnetic field on the steady, laminar, low-speed plane Couette flow of a slightly rarefied and electrically conducting gas are studied. Consideration is given to the slip-flow regime, wherein the gas rarefaction begins to play its important role. The generally accepted method of analysis for slip flows is utilized, i.e. the continuum magnetohydrodynamic equations of motion are used throughout the gas, together with the first and the second order slip velocity and temperature jump boundary conditions. Considerations are further given to (1) the case of zero electric field and (2) the case of a nonconducting channel in which the net current across the channel is zero. (auth)

49065 FLUCTUATING FLOW OF AN ELASTICO-VISCOUS FLUID ALONG AN INFINITE POROUS PLATE WITH AN APPLIED MAGNETIC FIELD. Shrestha, G. M. (Univ. of Florida, Gainesville). Appl. Sci. Res. (The Hague); 22: 295-305(May 1970).

The problem of oscillating free stream flow of an elastico-viscous, incompressible, and electrically conducting fluid along an infinite plate with suction varying periodically with time is considered in the presence of a transverse magnetic field. The effect of the elasticity of the fluid, the magnetic fluid, and the fluctuation of suction velocity on the velocity and the skin friction is examined. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 48955, 49015, 49058, 49223, and 49229.

49066 (AD-702799) THE PARTICLE ENVIRONMENT AT THE SYNCHRONOUS ALTITUDE. Report for January-June 1969. Paulikas, George A.; Blake, J. Bernard (Aerospace Corp., El Segundo, Calif.). 31 Dec 1969. Contract F04701-69-C-0066. 64p. (TR-66(5260-20)-15; SAMSO-TR-70-75). CFSTI.

The particle environment at synchronous orbit is summarized. Included is a discussion of the properties of the trapped relativistic electron fluxes and the phenomenology of the penetration of solar protons to synchronous orbit. (USGRDR)

49067 (AD-703293) THEORETICAL AND COMPUTATIONAL RADIATION HYDRODYNAMICS. VOLUME I. RADIATION HYDRODYNAMICS, THEORETICAL CONSIDERATIONS. Pomraning, G. C.; Wilson, Howard; Lindley, William (Gulf General Atomic, Inc., San Diego, Calif.). 26 Sep 1969. Contract DASA01-69-C-0012. 228p. (GA-9530(Vol.1); DASA-2392-1). CFSTI.

The report concerns theoretical consideration of radiation hydrodynamics including radiation transfer in a moving medium, effects of polarization on radiative transfer, the extended Eddington approximation and surface curvature. (USGRDR)

49068 (AD-703664) THEORETICAL AND COMPUTATIONAL RADIATION HYDRODYNAMICS. VOLUME II. THE DRAD CODE: COMPTON SCATTERING. Wilson, Howard L.; Lindley, William B.; Matteson, L. N. (Gulf General Atomic, Inc., San Diego, Calif.). 26 Sep 1969. Contract DASA01-69-C-0012. 249p. (GA-9530(Vol.2); DASA-2392-2). CFSTI.

A description of the nonequilibrium diffusion code, DRAD, with Compton scattering is given. Detail discussions are also given for retardation and flux limiters. (auth) (USGRDR)

49069 STIMULATED SECONDARY RESONANCES IN IONOSPHERIC PLASMA. Barry, James Dale. Los Angeles; Univ. of California (1969). 350p. University Microfilms Order No. 70-8111.

Thesis.

A set of infrequently detected resonance-like traces in the Alouette II ionogram data is described. The corresponding signals are shown to be stimulated by the ionosounder transmission, almost monochromatic, of about 100-μsec duration, and may be frequently dependent upon the local magnetic field. The relationships of the secondary resonances to the parameters of the plasma medium are derived. The index of refraction is imaginary and greater than one. Several source processes for the secondary resonance signals are discussed. These include fractional subharmonics of the plasma frequency f_N, beat frequencies between the normal plasma resonances f_H, f_N, f_T, and their harmonics, plasma resonances at angles defined by $\underline{K}$ and $\underline{B}$, and stimulated magnetic dipole transitions. It is shown that the data are most consistent with the latter process. The agreement is not complete, however. It is shown that the process may apply in the region below about 700 km. The metastable state number density at higher altitudes is less than that required by the process. Calculations of the production rates of the metastable states of oxygen (O, O^+) and nitrogen (N, N^+) are made from 500 to 2000 km. The production process is assumed to be the photo-ionization and photo-dissociation of the parent molecules and atoms. The wavelength-dependent solar euv fluxes, and the wavelength dependent cross sections for the various species are used in the calculations. An unexpected feature is the relatively significant production rates for $O^+(^2D)$, $O(^1D)$, and $N(^2D)$ at altitudes above 500 km. (Diss. Abstr. Int., B)

49070 ABSOLUTE CALCULATION OF SECONDARY COSMIC GAMMA RAYS AT THE TOP OF THE ATMOSPHERE. Jabs, Arthur; Wibberenz, Gerd (Univ., Kiel). Z. Phys.; 236: 101-29(1970).

Starting from the primary nucleon and the primary electron spectra the vertical secondary gamma spectra in 0 to 30 g/cm^2 atmospheric depth and the energy range 1 to 1000 GeV are calculated and compared with experimental data. The calculated spectra largely depend on the properties of the primary-nucleon-air-nucleus collision. The collision model is considered in detail. The influence of the relevant collision parameters, which are not very well known, on the gamma spectra is studied. In addition, the influence of the solar cycle and of the geomagnetic cutoff is shown. The conventional values of the collision parameters together with a lowered primary nucleon spectrum, as suggested by recent measurements by Schmidt et al., give theoretical gamma spectra that lie within the wide range of the experimental data. In the same way, the above assumptions can help to remove a discrepancy noticed a few years ago between measured and calculated muon and nucleon spectra in the atmosphere. (auth)

49071 RESPONSE METHOD FOR THE ANALYSIS OF GEOMAGNETIC MICROPULSATIONS. Ku, C. C.; Geldart, L. P.; Jones, F. W. (McGill Univ., Montreal). Phys. Earth Planet. Interiors; 2: 294-9(Jun 1970).

The nature of geomagnetic micropulsations is considered with reference to the response method of analysis. Under the assumption that the magnetosphere is a linear and time-invariant physical system, the system function for Pcs and pi2 is numerically calculated. An investigation of the general input-output relationships shows that the magnetogram recorded on the Earth's surface may

be due to either the resonant frequency of the magnetosphere or the input frequency of the solar wind. (auth)

49072 PERTURBATIONS OF THE GEOMAGNETIC FIELD AND ITS VARIATIONS IN THE 11-YEAR CYCLE. Ol, A. I. Tr. Gl. Geofiz. Observ.; No. 245, 35-48(1969). (In Russian).

The most important indices of magnetic disturbance are described, and the physical meaning of each index is discussed. The variations of magnetic disturbance in the 11-yr cycle of solar activity are examined. Different indices reflect different types of corpuscular solar emissions. The corpuscular radiation of the Sun consists of two types—bursts and recurrences, and these types vary differently in the 11-yr cycle; burst streams form most frequently near the maximum of solar activity and recurrent streams near the minimum. Accordingly, the cyclic curves of some indices of magnetic disturbance may have either two peaks or one peak, but with a very wide maximum. Various hypotheses on the origin of variations of magnetic disturbance are discussed. A table of mean monthly and mean annual values of the index of magnetic disturbance ($M = 10\Sigma K_p - 10$) is presented. (Meteorol Geoastrophys. Abstr.)

49073 ENERGY SPECTRA OF PRECIPITATING ELECTRONS FROM SIMULTANEOUS BALLOON OBSERVATIONS OF OPTICAL AND X-RAY AURORA. Christensen, Andrew Brent. Denver; Univ. of Denver (1969). 185p. University Microfilms Order No. 70-7529.

Thesis.

Simultaneous balloon observations of auroral N_2^+ (λ 3914) emission and bremsstrahlung x rays produced by the precipitation of energetic (~1 to 200 keV) electrons in the auroral zone suggest that two distinct groups of electrons are responsible for the observed effects. One group is mainly responsible for the x-ray flux above 40 keV; however, the total power deposited in the atmosphere by this group is seldom greater than a few tenths erg cm^{-2} sec^{-1}. The spectrum of these electrons can be represented by a simple exponential spectrum with an e-folding energy usually between 40 and 65 keV. A separate group of particles provides the major energy influx during optical aurora, and at times not only provides the dominant flux of x rays below about 40 keV but also accounts for most of the cosmic-noise absorption. A remarkable feature of this second group is the extent to which its average energy may vary, i.e., from several keV to greater than 25 keV during the post-midnight hours. A recognition of this feature of the spectrum leads to a better understanding of the relationship between optical, x-ray, and auroral absorption events. In conjunction with the study of electron spectra, calculations of the intensity of resonance-scattered 3914-A radiation from sunlit aurora are discussed. The calculations indicate that for electron spectra characterized by energies greater than 10 keV, the 3914-A intensity due to electron impact is enhanced less than 10% by resonance scattered sunlight. However, for characteristic energies less than 5 keV, the resonance scattered contribution becomes appreciable. (Diss. Abstr. Int., B)

49074 PERSISTENCE OF SOLAR AND GEOMAGNETIC ACTIVITY. Cehak, K.; Pichler, H. Arch. Meteorol., Geophys. Bioklimatol., Ser. A; 18: 147-65(1968). (In German).

The persistence of some parameters of solar and geomagnetic activity is investigated, using the method of variance spectrum analysis. The monthly means of sunspot numbers and the 10.7-cm-radiation flux show nearly identical autocorrelation functions with long persistence. The spectra contain only very long waves. The spectrum of the flare index contains a wave with a period of about 10 mo, but is otherwise very similar to the other solar spectra. The spectra of the series of the sum of K_p indices and of the series of A_p indices show waves with periods of about 2, 6, and 48 mo. This indicates that solar wind data are better for correlations with geomagnetic indices instead of the cited solar indices. (Meteorol. Geoastrophys. Abstr.)

49075 IONOSPHERIC D-REGION PARAMETERS FROM BLUNT PROBE MEASUREMENTS DURING A SOLAR ECLIPSE. Baker, Duncan Charles. University Park, Pa.; Pennsylvania State Univ. (1969). 110p. University Microfilms Order No. 70-7181.

Thesis.

A series of four rocket experiments were performed during the solar eclipse of November 12, 1966, at Cassino, Brazil, to determine the positive and negative conductivities of the atmosphere below 80 km. The conductivity data was interpreted in terms of positive and negative ion and electron densities. The density data was used with the positive ion continuity equation to determine the ion–ion recombination coefficient, α_i. It was found that α_i had to be of the order 10^{-6} cm^3 sec^{-1} between 70 and 78 km, decreasing to values more consistent with laboratory results below 70 km, in order to explain the observed changes in positive ion density. The x-ray production rates (Mavretic, 1968) and the cosmic-ray production rates were used to determine the contribution of ionization of NO by Lyman-α to the total production rate as obtained from the positive ion continuity equation. The Lyman-α production rate was in turn used to estimate the NO concentration between 65 and 78 km. The results are in excellent agreement with experimental results (Barth, 1966a and b and Pearce, 1968) and with a simple model based on the NO production mechanism proposed by Hunten and McElroy, (1968). A simple negative ion model (Fehsenfeld et al., 1967) was found to be successful in prediction of the observed electron and negative ion densities below 60 km for a given positive ion density. The terminal negative ion is tentatively identified as CO_3^- and/or NO_3^- on the basis of the model. The model was found to be unsuccessful above 60 km. An estimate was made of the O_2^- loss rate for a reaction leading to a stable negative ion or an ion for which the detachment rate is decreasing with altitude. It was concluded that O_2^- is not the dominant negative ion anywhere in the region 55 to 80 km and that reactions of ions with hydrogen compounds may be important to understanding D-region processes. (Diss. Abstr. Int., B)

49076 ANNULAR TRAP FOR LOW-FREQUENCY WAVES IN THE EARTH'S MAGNETOSPHERE. Gul'el'mi, A. V. (Inst. of Earth Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 12: 25-8(5 Jul 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 35-7 (5 Jul 1970).

An attempt is made to find conditions that permit a prolonged interaction between magnetic sound and high-energy particles. The unstable distribution of high-energy particles in the plasma surrounding the Earth leads to self-excitation of different types of electromagnetic waves. Alfven waves are observed on the Earth in the form of geomagnetic pulsations in the region of ~1 Hz. Alfven waves may cross the region of interaction with resonant particles many times by magnetic focusing and reflection from the ionosphere on opposite ends of the force tube. Magnetosonic waves are not subject to magnetic focusing, so their trajectories are complicated curves, and these waves leave the resonant region rapidly. Previous calculations are noted that show that the annular trap retains waves having frequencies from fractions of 1 hertz to several dozen hertz in a wide range of propagation directions. Hydromagnetic waves can be used as scattering centers or particles from the radiation belts. Since the plasmapause shifts slowly in the range $L \sim 3$ to 6, the waves accumulated in the annular trap act on the particles in the entire space of the outer radiation belt. (J.C.W.)

49077 ION CYCLOTRON RESONANCE MASS SPECTROMETRY. Goode, G. C.; O'Malley, R. M.; Ferrer-Correia, A. J.; Jennings, K. R. (Univ. of Sheffield, Eng.). Nature (London); 227: 1093-7(12 Sep 1970).

It is stated that this relatively new form of mass spectrometry is proving valuable in several branches of chemistry. The principal area of application has been in the study of ion collision processes, including ion–molecule reactions, which, in addition to their intrinsic interest, are important in radiation chemistry and in the chemistry of plasmas, flames, and the upper atmosphere. Details are given of the principles of the technique and some of the applications. The open construction of the cell, and the absence of discrimination effects at slits, are features of the technique which are only just beginning to be explored, and it is to be expected that an increasing range of applications will be found. (UK)

49078 ELECTROMAGNETIC RESONANCE PHENOMENA AND EQUIPMENTS TO STUDY THE RELATION BETWEEN SOLAR ACTIVITY AND THE MAGNETOPLASMA (IONOSPHERE). Agnelli, G. (Osservatorio Astronomico, Rome); Cimino, M.; Cutolo, M.; Puglisi, M. Advan. Phys.; 19: 217-68(Mar 1970).

A more exact definition of the lower ionosphere is given. The plasma exhibits a particular nonlinear behavior and has a layer (Bailey's layer) where considerable effects of electromagnetic resonance occur. After describing briefly the most recent work on the chemical, ionic, and electric structure of the D region, the reason for the nonlinear behavior of the plasma in this region is explained. Using V. A. Bailey's (1956 and 1965) theory of interaction and the Ginzburg–Gurevich (1960) kinetic theory, the concept of the plasma field is given, and it is shown how the latter theory allows greater precision in calculating G_{eff} and ν_{eff} and that among other things G_{eff} depends on the temperature. In order to have a more complete idea of the nonlinearity of a plasma the theories of D. Graffi (1936) and M. Marziani (1960) are given, including an expression for a general nonlinear equation of an electromagnetic field. Among the nonlinear effects known to date gyro-interaction, self-modulation, self-demodulation, and detection effect are considered. After defining the effect of the

gyro-interaction (Luxemburg effect with resonance) the essential features of the Bailey theory are given. A brief description is given of the experiments carried out which showed the existence of resonance in the Luxemburg effect during both day and night, both with pulses and cw, and the possibility of having a dromedary curve and a bactrian curve. It is also shown how it is possible to pass from one resonance curve to another. From a discussion of the phenomenon of self-modulation, it can be deduced that there are two different phenomena, that is, a self-demodulation that obviously is not dependent on the power of the wave and must be a linear phenomenon, and a self-modulation that clearly depends on the power and is a nonlinear effect that can be explained by the theory of interaction. Since it is not yet clear if the self-demodulation around the gyro-frequency depends on the power or not, the essential lines of the linear theory of Bailey, developed by Sodha and Kaw (1965), and the nonlinear theory of Sant Ram and Kaw (1967) are given. (auth)

49079 ELECTRICAL FIELD MEASUREMENTS IN IONOSPHERE WITH ARTIFICIAL PLASMA CLOUDS. Haerendel, Gerhard (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Naturwissenschaften; 56: 545-52(Nov 1969). (In German).

Methods for production of barium clouds are discussed as well as their deposition by rockets at various heights and latitudes. Ionization by sunlight, motion in the electric field, diffusion, and dependence on the magnetic field are discussed. Also analyzed are behavior of barium clouds near regions of aurora borealis, changes in shape caused by magnetic fields, and behavior at altitudes of 12.5 earth radii. Eleven pictures and diagrams are presented. (H.B.G.)

49080 PROBLEM OF THE AURORAL ABSORPTION ZONE SHIFTING DURING THE SOLAR ACTIVITY CYCLE. Gorbushina, G. N.; Zhulina, E. M. Probl. Arktiki Antarkiti; No. 29, 113-15 (1968). (In Russian).

In a previous paper (in press) the authors showed that auroral absorption is observed most frequently in years of reduced solar activity, and that the maximum frequency of occurrence of the absorption lags by 3 to 4 yr behind the maximum sunspot number. Graphs of latitudinal distribution of the frequency of occurrence at noon and midnight hours in the winters and summers of 1958 (year of maximum) and of 1962-1963 (years close to minimum of solar activity) are presented and discussed here. The data show that there is no correspondence between the level of magnetic activity and the frequency of appearance of auroral absorption. (Meteorol. Geoastrophys. Abstr.)

Low-Temperature Physics

Refer also to abstracts 49085, 49280, 49291, 49297, and 49604.

49081 (COO-1569-61) GROUND STATE OF LIQUID ^{4}He. Murphy, R. D. (Minnesota Univ., Minneapolis. School of Physics and Astronomy); Watts, R. O. (Waterloo Univ. (Ontario). Dept. of Applied Mathematics). [1969]. Contract AT(11-1)-1569. 25p. Dep. CFSTI.

A variational calculation of the ground-state energy of liquid ^{4}He is performed under the assumption that the ground-state wave function is a product of pair functions and the potential energy is a sum of pair potentials. Results obtained from the Percus-Yevick (PY) and Hypernetted Chain (HNC) theories are compared with both Monte Carlo (MC) studies and with experiment. It is found that in the case studied the PY equation is considerably less accurate than the HNC and that the PY is not useful for this variational calculation but that the HNC is. A comparison of three model pair potentials indicates that the uncertainty in the pair potential produces an uncertainty in the ground-state energy of about 2°K. One of the pair potentials used leads to the best agreement yet obtained with experimental ground-state energies. (auth)

49082 DOUBLY PUMPED RUBY MASER WITH A SUPERCONDUCTING MAGNET. Lewandowski, S. J.; Zarembinski, S. Postepy Fis.; 21: 419-21(1970). (In Polish).

A short notice on the design of a doubly pumped ruby maser and a superconducting magnet is given. (auth)

49083 CRYOGENICS AND NUCLEAR PHYSICS. PART II. Hammel, E. F.; Rogers, J. D.; Hassenzahl, W. V. (Los Alamos Scientific Lab., N. Mex.). Cryogenics; 10: 186-98(Jun 1970).

Recent cryogenic developments are described in beam-handling including superconducting accelerators, moderators, detectors, low temperature irradiation facilities, and other miscellaneous applications. (auth) (UK)

49084 ATTENUATION OF SOUND IN LIQUID HELIUM. Ichiyanagi, Masakazu (Osaka Univ.). J. Phys. Soc. Jap.; 29: 58-65(Jul 1970).

In terms of a two-particle Green function, the three-phonon process is formulated. The spectral function of the Green function is the dynamical liquid structure factor and there are two exact sum rules for it. Using Puff's expression for the dynamical structure factor, it is shown that one can reproduce results obtained by Pethick and ter Haar who formulated the three-phonon process in terms of a single-particle function. In the framework of this theory problems can be structured utilizing the fluctuation-dissipation theorem. A sum rule for the width $\Gamma(k, \omega)$, which is expressed as the time Fourier transform of the time correlation function of the random force acting upon the density fluctuation, is obtained. As long as $k^3\Gamma \ll k_BT$, the liquid structure factor $S(k)$ is given by $S(k) = (k/2mc) \coth [(\beta ck/2)] [1 - (1/32)\beta^2k^4\Gamma^2]$. The relation between the width $\Gamma(k, \omega)$ and the lifetime of phonons is discussed. Properties of the random force are also discussed. (auth)

49085 MACROSCOPIC WAVE FUNCTIONS AND WAVE EQUATIONS. Froehlich, H. (Univ. of Liverpool). pp 373-8 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

Exact wave equations for the macroscopic wave functions required in superfluids and superconductors are derived. (auth)

49086 . NONSTATIONARY EFFECTS IN RESISTIVE STATE OF SUPERCONDUCTING FILMS. Kulik, I. O. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz.; 59: 584-92(Aug 1970). (In Russian).

Fluctuations of the ordering parameter in a superconducting film in an electric field are investigated by the Langevin random force method at temperatures $T > T_c$ and $T < T_c$. A dropping part of the current-voltage characteristic arises in the resistive state below T_c. In this case, the fluctuations possess characteristic buildup times defined by the electric field strength and this leads to the appearance of favored radiation frequencies. The latter effect may be manifested in a nonmonotonous (oscillating) dependence of the film transparency on frequency of the incident electromagnetic wave. (auth)

49087 CRYOGENIC LABORATORY EQUIPMENT. Croft, A. J. The International Cryogenics Monograph Series. New York; Plenum Publishing Corporation (1970). 190p. $11.50.

The following subjects are covered: sources of cryogenic liquids; containers; methods for transfer; liquefiers and their associated machinery; methods and equipment for gas storage, purification, etc.; instruments for measurement of temperature, flow, level, leak detection, automatic control, etc.; materials and practical methods for making low-temperature equipment; special laboratory design features for low-temperature work; and the hazards of low-temperature work and precautions to be taken. (M.H.R.)

49088 TUNNELING MEASUREMENTS OF SUPERCONDUCTING QUASI-PARTICLE DENSITY OF STATES AND CALCULATION OF PHONON SPECTRA. Rowell, J. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Res. Nat. Bur. Stand.; 74A: 559-65(Jul-Aug 1970).

It is an unfortunate fact that the tunneling technique, which has proved incredibly successful in the study of superconductivity, has given little information about the normal-state properties of metals and semiconductors. It is shown that, in the determination of the superconducting quasi-particle density of states, it is the change in density induced by the onset of superconductivity that is measured rather than the total density. Returning to the problem of normal materials, a review of the limited achievements and failures of tunneling is presented. This includes the influence of band edges on tunneling in p-n diodes and metal-semiconductor contacts, the structures observed in tunneling into bismuth, and the negative results obtained in nickel and palladium. The dominant effect of the change in barrier shape in most of these tunneling characteristics is illustrated. (auth)

49089 SUPERCONDUCTORS CONTAINING IMPURITIES WITH AN INTRINSIC DEGREE OF FREEDOM. Ginsburg, S. L. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 59: 478-84(Aug 1970). (In Russian).

It is shown that introduction of impurities with an intrinsic degree of freedom appreciably alters the spectrum of the superconductor; in particular, gapless superconductivity arises. The appearance of a nonvanishing state density within the gap is the result of inelastic scattering of electrons by the impurities. (auth)

49090 PREPARATION AND SUPERCONDUCTING PROPERTIES OF NIOBIUM–ZIRCONIUM THIN FILMS. Spitzer, Hermann J. J. Vac. Sci. Technol.; 7: 537-42(Sep-Oct 1970).

Thin films (3000 to 4000 Å thick) of Nb–Zr were prepared by dc sputtering at 350 and 630°C. Measurements of the J_c–H characteristics in transverse fields of up to 85 kOe and of T_c's were carried out as a function of composition. The effects of different substrate materials and deposition rates on the superconducting properties of Nb–66 at. % Zr thin films deposited at 630°C were also investigated. The results show a distinct dependence of J_c–H data on the substrate temperature: maximum critical fields of up to 60 kOe at 10^3 A/cm² are observed for films deposited at 350°C, whereas some films deposited at 630°C are still superconducting at 85 kOe with current densities of 10^5 A/cm². The T_c vs composition curve has a maximum at approximately 30 at. % and appears to be insensitive to deposition temperature at higher Zr concentrations. Additional annealing after deposition seems to increase T_c. The lower deposition rates yielded films with higher T_c's and better J_c–H characteristics. (auth)

49091 THIRD-SOUND RESONANCE. Ratnam, B.; Mochel, J. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 25: 711-14(14 Sep 1970).

A thermodynamic state of thin helium films was obtained that permits precision measurements of their properties. Third-sound resonances indicate a cutoff for the propagation of third sound in these films. This cutoff is accompanied by an exponential rise in the dc thermal resistance of the helium film which indicates the formation of high-energy excitations of 0.08 eV. The dissipation at resonance is consistent with Bergman's theory for hydrodynamic dissipation of third sound. (auth)

49092 INVESTIGATION BY SECOND SOUND OF THE INERTIAL MASS OF ^{3}He IN SUPERFLUID ^{4}He AT LOW TEMPERATURES. Brubaker, N. R.; Edwards, D. O.; Sarwinski, R. E.; Seligmann, P.; Sherlock, R. A. (Ohio State Univ., Columbus). Phys. Rev. Lett.; 25: 715-18(14 Sep 1970).

From measurements of the velocity of second sound and the osmotic pressure the inertial mass of ^{3}He in superfluid ^{4}He has been obtained as a function of temperature and concentration. The results indicate that (i) the ^{3}He quasiparticle spectrum is not quite parabolic and (ii) part of the quasiparticle effective interaction is velocity dependent or nonlocal and resembles the interaction of spheres moving through a nonviscous classical fluid. (auth)

49093 CURRENT–VOLTAGE CHARACTERISTICS OF SMALL JOSEPHSON TUNNEL JUNCTIONS. Buckner, S. A.; Chen, J. T.; Langenberg, D. N. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 25: 738-41(14 Sep 1970).

A stable dc supercurrent with an extended negative-resistance region has been observed in the I–V characteristics of very small Josephson tunnel junctions. This supercurrent and its response to external noise are in accord with recent theoretical predictions of Ivanchenko and Zil'berman. (auth)

49094 EXPERIMENTAL DETERMINATION OF THE PAIR SUSCEPTIBILITY OF A SUPERCONDUCTOR. Anderson, J. T.; Goldman, A. M. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1569. Phys. Rev. Lett.; 25: 743-7(14 Sep 1970).

An excess tunneling current due to order-parameter fluctuations has been found in tin–tin oxide–lead junctions just above the transition temperature of tin. Details of the variation of the excess current with voltage, magnetic field, and temperature are in agreement with a calculation by Scalapino in which the excess-current voltage characteristic is a direct measure of the frequency—and wave-number—dependent pair susceptibility characteristic of the superconducting transition. Estimates of the pair relaxation frequency in tin based on the data are 50% greater than theoretical predictions. (auth)

49095 SUPERCONDUCTIVITY OF HYDRIDES AND DEUTERIDES OF THORIUM. Satterthwaite, C. B.; Toepke, I. L. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 25: 741-3(14 Sep 1970).

Superconductivity has been observed in the hydrides and deuterides of thorium with H- or D-to-metal atom ratios of 3.6 to 3.65. Transition temperatures fall in the range from 8.05 to 8.35 K. These materials are apparently type-II superconductors with H_{c_2} of the order of 25 to 30 kG at 1.1 K. There is no evidence for an isotope effect within the limits of experimental uncertainty. (auth)

49096 SUPERCONDUCTIVITY IN ROCKSALT-TYPE COMPOUNDS. Hulliger, F. (Laboratorium fuer Festkoerperphysik, Zurich); Hull, G. W. Jr. Solid State Commun.; 8: 1379-82(1970).

Rocksalt-type compounds with nonlocalized excess valence electrons appear to have a high likelihood of being superconducting above 0.3°K. Transition temperatures are reported for YS, YSe, YTe, LuS, and LuSe. (auth) (UK)

49097 ENHANCEMENT OF FLUX PINNING FOR SUPERCONDUCTORS WITH $\kappa = 1/\sqrt{(2)}$. Gifkins, K. J. (Monash Univ., Clayton, Australia). Solid State Commun.; 8: 1369-70(1970).

Where the Ginzburg–Landau parameter $\kappa = 1/\sqrt{(2)}$, a peak in the curve trapped flux vs. composition of Pb–Tl alloys is reported and explained by the influence of both point defects and fluxoid interaction. Furthermore, the role grain boundaries play in the pinning mechanism is investigated. (auth) (UK)

49098 QUANTUM INTERFERENCE AND SUPERCURRENT–PHASE RELATIONS IN WEAK-LINK JUNCTIONS. Fulton, T. A. (Bell Telephone Labs. Inc., Murray Hill, N. J.). Solid State Commun.; 8: 1353-7(1970).

The quantum interference properties of the supercurrent in weak-link double junctions are described taking explicit account of self-inductance and asymmetry. An associated technique for determining the junction supercurrent–phase relations is outlined and applied to point-contact junctions. (auth) (UK)

49099 LOW-FREQUENCY PHOTON-ASSISTED TUNNELING IN SUPERCONDUCTING TUNNEL JUNCTIONS. Sweet, J. N.; Rochlin, G. I. (Univ. of California, Berkeley). Solid State Commun.; 8: 1341-4(1970).

The photon-assisted tunneling response of Sn/SnO/Pb and Sn/SnO/Sn superconducting junctions to a 3.9 GHz microwave field has been measured. The experimental response of the tunneling current to the rf field agrees very closely with the response predicted by the theory of Tien and Gordon. The predictions of the Cook and Everett theory do not fit the data well. (auth) (UK)

49100 LOSSES DUE TO MOVING FLUXOIDS IN SUPERCONDUCTORS. Love, Gordon R.; Kroger, Donald M. (Oak Ridge National Lab., Tenn.). Phil. Mag.; 22: 583-60(Sep 1970).

A macroscopic description of the intermediate state in hysteretic superconductors, previously applied to the case of near-static fluxoid distributions, has now been extended to the case of fluxoids constrained to move at definable average velocities. The model allows the prediction, analytically and semiquantitatively, of the results of flux-flow experiments and it establishes an analytic correlation between those results and measurements of the frequency dependence of the apparent critical current density determined by ac magnetization. Since a number of physical parameters of the superconductors is incorporated into a model, a variety of checks on the validity of the model description is available. Samples having a single composition and metallurgical history were tested extensively, both in the flux-flow geometry and in ac magnetization, under a variety of test conditions. Analysis of these experimental results in terms of the model constitutes both a test of the model and a quantitative correlation between metallurgical structure and superconducting properties for this system. (auth) (UK)

49101 THEORY OF ELECTRON–ELECTRON INTERACTION AND SUPERCONDUCTIVITY IN DILUTE MAGNETIC ALLOYS ABOVE THE KONDO TEMPERATURE. Solyom, J. (Central Research Inst. for Physics, Budapest); Zawadowski, A. Z. Phys.; 226: 116-38(1969).

The effective electron–electron interaction resulting from the virtual polarization of the impurity spin is investigated. Abrikosov's pseudofermion representation of spin operators has been applied. It is pointed out that the effective electron–electron interaction consists of two parts: 1) elastic scattering; 2) inelastic scattering. The second part shows a singularity of new type as $(\omega-\omega')^{-1}$, where $\omega-\omega'$ is the energy transfer between the two electrons. Both parts have been calculated in logarithmic approximation. In spite of the fact that the second one is found to be lower by one order of the typical logarithmic Kondo terms than the first one, both terms can be of the same order of magnitude. Studying the superconducting transition temperature Abrikosov and Gor'kov's calculation is extended to include these interactions in any order of perturbation theory keeping the leading logarithmic terms. The results are restricted to the temperature region well above the Kondo temperature. Considering the decrease of the superconducting transition temperature due to the magnetic impurities in the antiferromagnetic case the effect of the elastic scattering can be essentially reduced by the inelastic one. (auth)

49102 MAGNETIC FORCES ON A COIL MOVING IN A CONDUCTING TUBE. Neil, V. Kelvin; Cooper, Richard K. (Univ. of California, Livermore). J. Appl. Phys.; 41: 4619-26(Oct 1970).

A theoretical investigation is made of the forces on a current ring moving in a conducting tube. The ring carries constant cur-

rent and moves with constant speed along the tube. The ring is coplanar with the circular cross section of the tube, with the center of the ring displaced downward from the axis of symmetry of the tube so that the asymmetric image currents provide a lift force on the ring. The wall of the tube has finite thickness and finite conductivity. The lift and drag forces exerted on the ring by the wall currents are calculated. The minor radius of the ring is neglected, and within this approximation, the calculations are exact. (auth)

Plasma and Thermonuclear Physics

49103 (TID-3557(1967-68 Suppl.)) CONTROLLED FUSION AND PLASMA RESEARCH. A Literature Search. Whitson, Milton O. (comp.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Aug 1970. 830p. Dep. CFSTI $10.00.

This search includes 5148 references on various aspects of plasma physics and controlled thermonuclear research. Report number, author, corporate author, and subject indexes are included. (auth)

49104 (UCB-34-P-128-15) FIRST QUARTERLY PROGRESS REPORT OF 1970 ON PLASMA RESEARCH, JANUARY 1–MARCH 31, 1970. (California Univ., Berkeley. Electronics Research Lab.). Contract AT(04-3)-34. 143p. Dep. CFSTI.

ELECTRON BEAMS—interactions with plasma, ion heating from modulated (E/T)
MAGNETIC MIRROR MACHINES—plasma density and energy in compression experiment
PLASMA—diagnostics of lithium, in magnetic mirror compression experiment
—diagnostics using neutral potassium beams
—heating at electron cyclotron frequencies, breakdown of adiabatic invariance in
—simulation of magnetized, difference schemes for
—stability of, analysis of density gradient-driven collisional drift
—wave propagation in inhomogeneous magnetized, dispersion relations for oblique
POTASSIUM—plasma of, stabilization of oscillations in rotating (E) (M.O.W.)

49105 RAREFIED GAS DYNAMICS. VOLUME I. Proceedings of the Sixth International Symposium, Cambridge, Massachusetts, July 22–26, 1968. Trilling, Leon; Wachman, Harold Y. (eds.). Advances in Applied Mechanics. Supplement 5. New York; Academic Press Inc. (1969). 952p. $22.50. (CONF-680730-(Vol.1)).

Volume I contains approximately 90 papers on the following two major areas: (1) kinetic theory and its applications to shear flows and shock wave structure, and (2) transition flow particularly past plates, wedges, and cones, through tubes and orifices, past spheres and cylinders, and in other configurations. (M.O.W.)

49106 RAREFIED GAS DYNAMICS. VOLUME II. Proceedings of the Sixth International Symposium, Cambridge, Massachusetts, July 22–26, 1968. Trilling, Leon; Wachman, Harold Y. (eds.). Advances in Applied Mechanics. Supplement 5. New York; Academic Press Inc. (1969). 938p. $22.50. (CONF-680730-(Vol.2)).

Volume II includes approximately 90 papers on the following three areas: (1) low-density jets, (2) gas–surface interaction, scattering, energy exchange of internal modes in collisions among molecules and at surfaces, and (3) plasma flows in geophysics, astrophysics, and other conditions. (M.O.W.)

Confinement and Heating

Refer also to abstract 49218.

49107 (ORO-3871-4) QUASISTATIC ION CYCLOTRON WAVE STUDIES. Progress Report. Swanson, Donald Gary (Texas Univ., Austin. Plasma Research Lab.). 15 Aug 1970. Contract AT(40-1)-3871. 40p. Dep. CFSTI.

Theoretical studies of quasi-static ion cyclotron waves are described. The effects of collisions were studied and found to have a rather strong effect on the propagation characteristics in a low-temperature plasma, and that while the basic wave phenomena is essentially density-independent, the collision terms must be considered. It was also found that with self-consistent solutions, electron Landau damping is small only over a narrow band near cutoff. Both effects are included analytically, with numerical solutions for the effects of electron Landau damping versus ion cyclotron damping. The potential use of such waves for plasma heating is discussed. (M.O.W.)

49108 ADIABATIC COMPRESSION TO TOKAMAK DISCHARGES. Furth, H. P.; Yoshikawa, S. (Princeton Univ., N. J.). Phys. Fluids; 13: 2593-6(Oct 1970).

Adiabatic compression in minor and major radius is shown to facilitate the attainment of dense, high-temperature plasmas in the Tokamak configuration. (auth)

49109 CONTAINMENT OF PLASMA IN STATIONARY MAGNETIC AND HIGH-FREQUENCY FIELDS. III. Klima, R. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 20: 1018-29(1970).

Lower limits are derived for the high-frequency field pressure necessary for elimination of the loss cone of a mirror vessel. The self-consistent circularly polarized field is considered, the frequency being near to the cyclotron frequency of an electron or of an ion. The field pressure can be amplified by appropriately chosen dielectric slabs. (auth)

49110 LIFETIME OF CHARGED PARTICLES IN PLASMA IN THE TOKAMAK TM-3. Kuznetsov, E. I. This paper was summarized in At. Energ. (USSR); 25: 315-16(Oct 1968) as paper No. 234. (In Russian).

Measurements of the absolute intensities of the H_α and H_β lines were performed on a "Tokamak TM-3" installation for macroscopically stable discharge regimes in longitudinal magnetic fields having intensities of 9 to 24 kOe at discharge currents of 16 to 40 kA. The initial hydrogen pressure was varied from 4×10^{-4} to 1.3×10^{-3} torr. The duration of the discharge amounted to 6 millisec. The average value of the electron concentration was measured simultaneously by means of a radio interferometer operating at a wave length of 2 mm. Data on the electron temperature were taken from measurements performed previously on the "Tokamak TM-3" installation in operating regimes identical to the investigated ones. Taking the different corrections and measurement errors into account, the systematic error for the charged-particle lifetime calculated from these data amounts to 50 to 70%, while the random error is approximately 25%. The lifetime of the charged particles in the plasma was found to equal 2 to 6 millisec for the investigated regimes. (TSS)

49111 ION HEATING IN A MIRROR TRAP. Akshanov, V. S.; Bagirov, K. P.; Volkolupov, Yu. Ya.; Lysenko, M. A. This paper was summarized in At. Energ. (USSR); 25: 134(Aug 1968) as paper No. 216. (In Russian).

The results obtained from experimental studies of the plasma ion heating mode are outlined. The plasma is heated by injecting electron fluxes into a mirror trap; these fluxes have a large velocity component perpendicular to the direction of the magnetic field. The shift from electron heating to effective ion heating in the plasma is accomplished by greatly increasing the intensity of the injected beam and the simultaneous buildup of low frequency oscillations in the plasma. Neutral- and charged-particle analyzers were used to study the energy distribution of fast ions and neutral atoms leaving the plasma in directions perpendicular and parallel to the magnetic field. The ion temperature was determined from the obtained energy distributions. The fact that the temperature can be measured in this way was confirmed by determining the ion temperature of the neutron yield from the deuterium plasma. The effect of the perpendicular velocity component of the beam on ion heating was studied. It is shown that maximum heating of the ions occurs in conjunction with a minimum pitch in the beam "spiral" and, simultaneously, with an increase in ion oscillations. Thus, by changing the perpendicular velocity component of the beam one can control the development of both high- and low-frequency oscillations. By probing the plasma with beams of fast neutral atoms, measuring the intensity of the spectral lines of hydrogen (H_α and H_β), etc., it is established that a high degree of ionization exists in the plasma ion heating mode—the neutral gas begins to "burn." Calorimetric measurements showed that ~30 to 40% of the beam power goes into heating the plasma particles. It is therefore probable that a large mass of electrons and ions can be heated in traps to temperatures of the order of several keV. The low- and high-frequency power radiated by the plasma was measured. The relative percentage of high- and low-frequency oscillations was established and its association with the heating of the plasma electrons and ions was determined. (TSS)

49112 FORMATION AND CONFINEMENT OF A STRAIGHT PLASMA IN A HIGH-FREQUENCY QUADRUPOLE MAGNETIC FIELD. Orlinskii, D. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 78-88(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 113-27(Jan 1970).

The dynamic stabilization of a straight plasma by a high-frequency magnetic field was studied experimentally. A study of the initial stage of the straight pulsed discharge in the high-

frequency field indicates that the plasma is formed through the contraction of the plasma toward the axis of the discharge tube at an initial current growth rate greater than 2×10^5 A/sec. After the contraction the plasma is maintained at equilibrium until the continuously growing current reaches a certain critical value. A comparison of the stabilization method with theory indicates that the plasma collapse is due to violation of the stability criterion for long-wavelength deformations. (auth)

49113 TRANSIT-TIME OSCILLATIONS OF ELECTRONS IN A MAGNETIC TRAP. Volosov, V. I.; Pal'chikov, V. E.; Tsel'nik, F. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 94-6(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 134-7(Jan 1970).

The accumulation and confinement of fast electrons (up to 100 keV) in a magnetic trap were studied. The primary instability observed experimentally is related to the motion of the electrons between the magnetic mirrors; this instability limits the density of "hot" plasma. Several features of these oscillations are reported and a qualitative theory that describes the experimental results is derived. (auth)

49114 ION HEATING BY AN UNSTABLE PLASMA BEAM IN A MIRROR SYSTEM. Nezlin, M. V.; Taktakishvili, M. I.; Trubnikov, A. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 292-4(Aug 1970).

Translated from Zh. Tekh. Fiz.; 40: 392-5(Feb 1970).

The ion heating in the system was supplemented by the location of a fine metal grid inside the beam to which a (negative) floating potential was applied. The advantages and disadvantages of the method are outlined. (M.O.W.)

49115 FINITE-AMPLITUDE INSTABILITY IN A BOUNDED PLASMA. Kondratenko, A. N. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 502-4 (Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 649-51(Mar 1970).

A mechanism which can account for ion heating by the fast magneto-acoustic wave is considered. The instability of an inhomogeneous constant drift of plasma particles across the magnetic field is investigated. (auth)

Diagnostics

Refer also to abstracts 49077 and 49199.

49116 DEVIATIONS FROM MAXWELLIAN IN THE ELECTRON VELOCITY DISTRIBUTION FUNCTION OF A θ-PINCH PLASMA. Gondhalekar, A. M.; Kronast, B.; Benesch, R. (National Research Council of Canada, Ottawa). Phys. Fluids; 13: 2623-5(Oct 1970).

Incoherent scattering of laser radiation from a high-temperature θ-pinch plasma is used to determine the electron velocity distribution. Differences from Maxwellian, namely, a blue shift, and a deviation in the red wing of the spectrum are noted. (auth)

49117 ANOMALOUS RESISTANCE OF A PLASMA IN A STRONG MAGNETIC FIELD. Dykhne, A. M. Zh. Eksp. Teor. Fiz.; 59: 641-7(Aug 1970). (In Russian).

Fluctuations in a plasma located in a strong magnetic field result in a considerable change of its electric characteristics. Exact expressions for the effective conductivity and effective Hall parameter can be obtained when the inhomogeneities are strongly extended along the magnetic field and are randomly alternating regions with high or low plasma densities. It is shown that in such a system located in a strong magnetic field, the conductivity is inversely proportional to the field strength and the Hall coefficient is independent of the field strength (it is saturated). (auth)

49118 PROBE MEASUREMENTS BEHIND A STRONG SHOCK WAVE IN AIR. Gorelov, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 144-8(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 198-205(Jan 1970).

A double electrostatic probe is used as a means of measuring the electron temperature T_e behind a shock wave in air (0.5 to 1.0 mm Hg, $M_s \approx 20$). The probe is driven by a sine wave at 150 to 200 kHz, and the characteristic is recorded in 2.5 to 3.3 μsec. The probe measurements of T_e agree with those obtained from line reversal. The distribution of T_e behind the front is presented. Probe measurement of the ion density n_i is discussed. (auth)

49119 OPTICAL PROBE DIAGNOSTICS OF PLASMA IN WEAK-CURRENT ARC DISCHARGE. II. Batenin, V. M.; Chinnov, V. F. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp.; 7: 401-7(May-Jun 1969). (In Russian).

An optical probe was used in studies of resonance emission from a positive column electric arc burning in argon–potassium mixtures. Data are presented on radiant flux and its divergence as coordinates in an optically inhomogeneous and nonequilibrium plasma column. Radial distributions of T_e, N_e, and T_g parameters were used for determining the basic components of the electron energy balance, and their relative roles in the process of energy transport from the central zone of the arc to the periphery are discussed. (tr-auth)

49120 PROBE SATURATION ION CURRENT AT INTERMEDIATE PRESSURES IN THE COLD-ION LIMIT. Nemchinskii, V. A. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 314-16(Aug 1970).

Translated from Zh. Tekh. Fiz.; 40: 416-19(Feb 1970).

The saturation ion current to a cylindrical probe or spherical probe is calculated in the case where the ion temperature is much lower than the electron temperature, and where the initial ion velocities immediately after scattering (charge transfer) can be neglected. The relationship between the ion mean free path length l_i and the radius R_{P_r} of the probe is arbitrary. In the limit as $l_i/R_{P_r} \to \infty$ and $l_i/R_{P_r} \to 0$, the solution transforms to the solution obtained by Allen et al. and by Kagan and Perel', respectively. (auth)

49121 MEASUREMENT OF PLASMA RADIATION IN THE MILLIMETER REGION USING INTERFERENCE FILTERS. Balakhanov, V. Ya.; Zhivotov, V. K.; Krotov, M. F.; Rusanov, V. D.; Striganov, A. R.; Titov, A. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 340-4(Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 445-9(Mar 1970).

The use of interference filters for measuring microwave radiation from a plasma is demonstrated. An instrument is described for the investigation of the radiation in the wavelength range 3.5 to 17 mm. The results of an experiment on the measurement of the noise spectrum of a turbulent plasma are presented. (auth)

49122 SATURATION ION CURRENT TO A PROBE AT HIGH AND INTERMEDIATE PRESSURES. Moizhes, B. Ya.; Nemchinskii, V. A. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 317-19(Aug 1970).

Translated from Zh. Tekh. Fiz.; 40: 419-23(Feb 1970).

A theory is discussed that applies for an arbitrary ratio between the probe radius and the ion mean free path. The effect of different electron and ion temperatures is discussed. (M.O.W.)

49123 DETERMINATION OF PLASMA DENSITY FROM PROBE ION CHARACTERISTICS OVER A WIDE PRESSURE RANGE. Dyuzhev, G. A.; Kaplan, V. B.; Startsev, E. A. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 320-2(Aug 1970).

Translated from Zh. Tekh. Fiz.; 40: 424-6(Feb 1970).

Calculations performed for a weakly ionized plasma in which the Debye radius is much shorter than the radius of the probe and the mean free path with no ion generation in the sheath, are checked experimentally. It is shown that the plasma density can be determined from the ion saturation current of the probe characteristic over a broad range of pressures and for almost any T_e/T_i. (auth)

49124 INFLUENCE OF THE FIRST GRID ON THE CHARACTERISTICS OF A MULTIGRID ENERGY ANALYZER. Moskalev, I. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 371-6(Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 482-8(Mar 1970).

Ion temperature measurements using a multigrid energy analyzer rely on the linear dependence of the logarithm of the collected current, $\ln i_c$, on the retarding potential U_z applied to the collector. However, a good linear relationship between these two quantities is observed in practice only when the retarding potential is from three to five times larger than the ion temperature and the signal from the collector is reduced by two and a half orders of magnitude. Hence the signal-to-noise ratio is small; this feature makes it hard to obtain reliable data when operating with high retarding potentials, and the value of the ion temperature deduced in this way is not precise. One of the reasons the relationship between $\ln i_c$ and U_z is not linear is the finite thickness of the first grid. Particles for which the ratio of the transverse to the longitudinal velocity is large may hit the grid and miss the collector. The initial Maxwellian velocity distribution is then modified in a way that causes $\ln i_c$ to be less sensitive to U_z for small values of U_z. An estimate is made of the perturbation of the spectrum of those particles which succeed in traversing the first grid, and the retarding characteristics $i_c = f(U_z)$ were calculated as a function of the ratio of the diameter 2R of the mesh element of the grid to the thickness l of the wire. It is shown that when the potential of the first grid equals the plasma potential this

effect is substantial for grids with R/l ≤ 2. For long narrow channels R/l ≪ 1, and the dependence of ln i_c on U_z is nonlinear. In this case the temperature calculated from the slope of ln i_c can be two and a half times higher than its real value. (auth)

49125 ACCURACY OF THE RESONATOR METHOD OF DETERMINING ELECTRON DENSITY. Ivanov, B. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 377-82(Sep 1970). Translated from Zh. Tekh. Fiz.; 40: 489-95(Mar 1970).

The problems of increasing the accuracy of the resonator method, the experimental determination of the form factors with respect to the electron beam, and the use of multimode resonators to measure electron density are investigated. Experimental and theoretical values of the form factors are given for several TM and TE modes. The possibility of the absolute measurement of the "running" electron density with an accuracy of about 10% is established. The results of measurements show good agreement with the calculated results. (auth)

Kinetics (General)

49126 (NP-18450) PLASMA PARTICLE BALANCE IN THE POSITIVE COLUMN OF A DISCHARGE IN HELIUM. Rijnhuizen Report 70-58. Mewe, R. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Apr 1970. 42p. Dep. CFSTI (U. S. Sales Only).

The plasma particle balance is studied for the stationary positive column in helium at intermediate pressure (0.1 to 10 torr). Deviations from the ambipolar Schottky theory owing to the influence of ion inertia, space-charge sheath, stepwise ionization, and other effects are introduced in the form of a numerical correction factor. With the aid of computed values of the ionization rate, various characteristics in an E/p-pR diagram are calculated and compared with measurements. (auth)

49127 MULTIPLE SCATTERING AND ENERGY LOSS OF A FAST TEST ELECTRON BEAM IN A PLASMA. Lampe, Martin (Naval Research Lab., Washington, D. C. New York Univ.). Phys. Fluids; 13: 2578-89(Oct 1970).

For a tenuous monoenergetic electron beam incident on a quiescent plasma, the number and mean energy loss of electrons scattered through angle θ are calculated. The beam density is assumed so low that the collision frequency exceeds the growth rate of unstable plasma oscillations, preventing the development of a two-stream instability. The resulting test particle quantum Lenard-Balescu equation is solved. In the very-small-θ, multiple scattering regime, the energy loss rate becomes approximately independent of θ, but is about 20% smaller than the "stopping power," or energy loss rate averaged over θ. Dynamic shielding effects, especially Cherenkov emission of plasma oscillations, contribute significantly to the energy loss rate. Also in the multiple scattering regime, the distribution over θ is approximately Gaussian, as has been shown by other workers, and dynamic shielding results only in small new corrections, principally to the width of the Gaussian. The transition to single scattering, which begins at $\theta \gtrsim 5°$ for parameters considered, is also studied. In the single scattering regime, the distribution over θ is non-Gaussian, and the energy loss depends strongly on θ. The calculation is quantitatively accurate only for $\theta \lesssim 20°$. (auth)

49128 ELECTRON COOLING AND DIFFUSIVE FLOW OF DECAYING WEAKLY IONIZED PLASMA. Konenko, O. R. (All-Union Electrical Engineering Inst., Moscow). Teplofiz. Vys. Temp.; 7: 392-400(May-Jun 1969). (In Russian).

Experimental and theoretical data are given on the problem of electron cooling in diffusive flow of decaying plasma. Numerical calculations are made for the dimensionless gradient of electron temperature in hydrogen, helium, neon, and argon, and in helium with small admixture of hydrogen. (tr-auth)

49129 CONDUCTANCE PEAKS IN A CYLINDRICAL PLASMA CAPACITOR AT THE CYCLOTRON HARMONICS. Downward, J. G.; Harp, R. S. (California Inst. of Tech., Pasadena). J. Appl. Phys.; 41: 4652-8(Oct 1970).

Theoretical and experimental results are presented for the conductance peaks at the cyclotron harmonics in a plasma-filled cylindrical capacitor. A theory is developed and is shown to predict peak height variation with density, harmonic number, and sheath thickness that is in agreement with experimental observation. A harmonic conductance peak is found to rise initially as density increases, only to fall to a minimum height as the upper hybrid frequency passes through that harmonic. Possible applications of this work to plasma diagnostics and further research are mentioned. (auth)

49130 EXPERIMENTAL AND THEORETICAL INVESTIGATIONS OF NONEQUILIBRIUM EFFECTS IN STATIONARY HELIUM PLASMAS UNDER NORMAL PRESSURE. Uhlenbusch, J.; Fischer, E.; Hackmann, J. (Technische Hochschule, Aachen). Z. Phys.; 238: 404-20(1970). (In German).

Measurements and calculations of temperature, densities and field strength-current characteristics of cascaded arcs (0.15 and 0.3 cm radius) burning in helium under normal pressure are reported. It is shown that the evaluation of measured arc data assuming Saha equilibrium is not in agreement with the detailed solution of the balance equations. The temperature of electrons and heavy particles as well as the density of electrons and neutrals must be determined as independent variables from the rate equation for ground-state neutrals, from the equation of state, and from the energy balance of the electron gas and of the total plasma. The latter equation can be replaced by relations between measured intensities and the state variables. The deviations from Saha equilibrium are mainly caused by diffusion of neutral particles into the arc core and of charged particles into the opposite direction. The theoretical results derived from the balance equations are compared with spectroscopic line intensity and line width measurements. The agreement is good even if the equilibrium conditions are strongly violated. (auth)

Kinetics (Experimental)

Refer also to abstract 48995.

49131 (AEC-tr-7170) ROLE OF REPEATED IGNITION OF DISCHARGES IN ZETA-PINCH DYNAMICS. Kvartskhava, I. F.; Matveev, Yu. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). Translation of report NP-18065. 12p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 5162. (M.O.W.)

49132 MEASUREMENT OF THE VISCOSITY OF ATMOSPHERIC ARGON FROM 3500 TO 8500°K. Aeschliman, Daniel P. (Sandia Labs., Albuquerque, N. Mex.); Cambel, Ali Bulent. Phys. Fluids; 13: 2466-77(Oct 1970).

A direct-current, wall-stabilized arc, constrained to cylindrical symmetry by a precision-bore Vycor tube, was used to measure the viscosity $\mu(T_g)$ of atmospheric pressure argon over the heavy-particle temperature range $3500 \leq T_g \leq 8500°K$. Streak photography from perpendicular directions of 20-30 μ graphite particles yielded the velocity profile u(r), from which the velocity gradient du/dr was obtained; the axial pressure gradient was determined with a micromanometer attached to taps in the arctube wall. These data were employed to solve the axial-component momentum equation for $\mu(r)$. $T_g(r)$ was determined from a linear similarity relation between u(r) and the heavy-particle enthalpy, $h_g(r)$. T_g on the axis was found from absolute line and continuum measurements of the electron temperature, allowing for a small departure from kinetic equilibrium. The radius r was eliminated from $\mu(r)$ and $T_g(r)$ to yield $\mu(T_g)$; the data are represented to within about 1% by $\mu(T_g) = 3.094 \times 10^{-8} T_g^{0.740}$ g/cm-sec, with an experimental uncertainty of about ±12%. (auth)

49133 VALIDITY OF THE LOCAL THERMAL EQUILIBRIUM ASSUMPTION IN ELECTROMAGNETIC SHOCK TUBES. Lie, T. N. (Catholic Univ. of America, Washington, D. C.); Rhee, M. J.; McLean, E. A. Phys. Fluids; 13: 2492-8(Oct 1970).

In order to check the assumption of local thermal equilibrium in a transient plasma with $kT_e \sim 4$ eV and $N_e \sim 10^{17}$ cm^{-3}, the electron temperature was determined by measuring both the spectral line intensity ratio of He II 4686 Å, and the laser light scattered by the plasma. The former method is strongly dependent on the local thermal equilibrium assumption, whereas, the latter method is independent of this assumption. These measurements were made on incident and reflected shock waves produced in an electromagnetic T-tube which had been prefilled with helium or hydrogen to a pressure of 0.5 to 1.0 torr. Within the experimental uncertainty of ±15%, the two electron temperatures agreed, indicating that the assumption of local thermal equilibrium used in the spectroscopic temperature determination is a reasonable approximation. Validity criteria for local thermal equilibrium given by Griem are examined for these conditions. (auth)

49134 HIGH-BETA PLASMA INJECTION INTO LINEAR MULTIPOLE FIELDS. Turner, R. (Johns Hopkins Univ., Silver Spring, Md.). Phys. Fluids; 13: 2597-2605(Oct 1970).

Two linear multipole fields, a 3-kG octopole and a 2-kG Ioffe field were studied experimentally as guide fields for the high-beta output of a plasma gun. In the octopole field a large fraction of the original plasma was lost to the walls; the amount and location of

the loss depended on the direction of the octopole field. The loss is attributed to unstable plasma in the region behind the octopole bars that short circuits the polarization field necessary for the plasma to move along the guide field. The octopole field does not offer any advantage over the simpler B_z field as a guide field for the present plasma. A rotational instability, at a frequency of up to 1 MHz, resulted in a large plasma loss through the cusp regions of the Ioffe field. As a result, it also proved to be a much poorer guide field than a B_z field. (auth)

49135 EXPERIMENTAL INVESTIGATION OF FLUXES OF FAST NEUTRONS FORMED IN A BEAM–PLASMA SYSTEM. Berezina, G. P.; Fainberg, Ya. B.; Berezin, A. K. This paper was summarized in At. Energ. (USSR); 24: 465-6(May 1968) as paper No. 205. (In Russian).

An experimental investigation was made of the processes of energy transfer from the electron beam to the plasma ions as a result of collective processes in the plasma–beam discharge in a uniform magnetic field. The conditions were determined for intense ion fluxes to arise in such a discharge, and the characteristics of the fluxes (density, current, energy, and pulse duration) in relation to the electron beam current, the pressure (plasma density), and the intensity of the longitudinal magnetic field were measured. Energy spectra are given for longitudinal and transverse ion fluxes. It is shown that in optimal conditions two intense high-energy ion fluxes in the direction of motion of the beam are formed in a plasma–beam discharge. (TSS)

49136 CURRENT DISTRIBUTION IN A COAXIAL ACCELERATOR. Belan, N. V.; Kiryushko, V. I.; Mashtylev, N. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 118-22(Jul 1970).
Translated from Zh. Tekh. Fiz.; 40: 164-9(Jan 1970).

Magnetic probe measurements are presented of current distribution over the length of the accelerating electrodes in a coaxial injector. It is found that the current is continuously distributed over the length of the accelerating electrodes in such a fashion that a portion of the current flows along the surface of the insulator during the discharge. The results of local current measurements with a differential magnetic probe within the accelerator are compared with integral current measurements in the acceleration circuit by means of a Rogowski loop. A technique for quantitative current measurements with a differential magnetic probe is presented. (auth)

49137 CORRELATION STUDY OF A PENNING DISCHARGE. Berezin, A. B.; Bulyginskii, D. G.; Vil'dzhyunas, M. I.; Rodichkin, V. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 101-5(Jul 1970).
Translated from Zh. Tekh. Fiz.; 40: 142-8(Jan 1970).

Correlation analysis is applied to determine the size, shape, and rotation rate of the plasma flute in a Penning discharge. The results provide an estimate of the coefficient for turbulent diffusion across the magnetic field. (auth)

49138 MICROWAVE RADIATION FROM A REFLEX DISCHARGE IN AN INHOMOGENEOUS MAGNETIC FIELD. II. Kuznetsov, Yu. K.; Pavlichenko, O. S.; Iosel'son, G. L. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 89-93(Jul 1970).
Translated from Zh. Tekh. Fiz.; 40: 128-33(Jan 1970).

This is a continuation of a study of microwave radiation from a cold-cathode reflex discharge in a slightly inhomogeneous magnetic field (Sov. Phys. — Tech. Phys., 13: 1030(1969)). This study is devoted to the intense cyclotron radiation observed when the detector frequency is very different from the electron cyclotron frequency and its harmonics. (auth)

49139 BREAKDOWN OF THE ELECTRODE SHEATH IN A MOVING ARGON PLASMA. Goryachev, V. L.; Sukhov, G. S. (Leningrad Military Engineering High School). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 326-7(Aug 1970).
Translated from Zh. Tekh. Fiz.; 40: 429-30(Feb 1970).

The volt–ampere characteristics of an argon plasma moving between cold electrodes in crossed electric and magnetic fields are described. An electrical breakdown in the electrode sheath is observed. The dependence of the breakdown voltage and the electrode potential drop on the plasma pressure, dimensions of the electrode, and the magnetic field amplitude are established. (auth)

49140 AMBIPOLAR PLASMA DIFFUSION WITH RECOMBINATION. Brodskii, V. B.; Kolokolov, N. B. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 383-6(Sep 1970).
Translated from Zh. Tekh. Fiz.; 40: 496-501(Mar 1970).

The properties of a high-voltage glow discharge in argon in a large volume (the radius of the discharge cylinder is 50 cm) are investigated. Probe methods are used to obtain the basic parameters of the plasma, namely, the density, electron temperature, space potential and the electron energy distribution. An equation for determining the density is derived for the region of the discharge in which ionization processes can be neglected. It is shown that the observed distribution of the electron density in this region is accounted for by the combined effect of ambipolar diffusion and dissociative recombination of electrons with molecular ions Ar_2^+. Under certain conditions, that were satisfied in the experiment, these processes are described by a linear differential equation. By comparing the computed and experimental values of the density, the rate coefficient for the formation of molecular ions Ar_2^+ is determined. The value of the coefficient obtained is $\gamma = 8 \times 10^{-32}$ cm^6/sec. (auth)

49141 EXCITATION OF ION-CYCLOTRON OSCILLATIONS IN A PLASMA FORMED BY AN ION BEAM. Gabovich, M. D.; Soloshenko, I. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 184-7(Aug 1970).
Translated from Zh. Tekh. Fiz.; 40: 254-8(Feb 1970).

Excitation of oscillations at the ion cyclotron frequency and its harmonics are observed in a plasma formed by the passage of an ion beam through a neutral gas in a magnetic field. It is shown that the oscillations are purely azimuthal waves with m = 1; the direction of propagation coincides with the direction of the cyclotron drift of the ions. A radial electric field, directed toward the center of the beam, stabilizes the oscillations. A field of opposite sign leads to growth of the oscillation. The possibility of stabilization of hf oscillations ($\omega \ll \omega_{Hi}$, where $\omega_{Hi} = eH/M_ic$ is the ion cyclotron frequency) by electric fields has been demonstrated earlier. (auth)

49142 ELECTRON ENERGY SPECTRUM IN A LINEAR PLASMA BETATRON. Lutsenko, E. I.; Fainberg, Ya. B.; Pedenko, N. S.; Vasil'chuk, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 410-14(Sep 1970).
Translated from Zh. Tekh. Fiz.; 40: 529-34(Mar 1970).

The acceleration of electrons in a linear plasma betatron is investigated. The instabilities that cut off the acceleration in a cylindrical plasma betatron are convective and can be carried out of the system before they are highly developed. The current of accelerated electrons is ~1000 A. The measurement of the energy of the electrons shows that the energy is close to the total accelerating voltage. A significant difference is observed between these results and the results obtained with cylindrical plasma betatrons. (auth)

49143 HIGH-POWER DISCHARGES IN GASES. I. EXPERIMENTAL INVESTIGATION OF OPTICAL AND ENERGY CHARACTERISTICS OF A HIGH-POWER DISCHARGE IN AIR. Basov, N. G.; Borovich, B. P.; Zuev, V. S.; Rozanov, V. B.; Stoilov, Yu. Yu. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 399-404(Sep 1970).
Translated from Zh. Tekh. Fiz.; 40: 516-22(Mar 1970).

An experimental investigation was made of a high-power discharge in air (current ~ 400 kA) at an energy input to 25 kJ in a time 2×10^{-6} sec. Measurements were made of the current and voltage, the rate of expansion of the channel, and the absolute radiation intensity at various frequencies, thus allowing an energy balance to be performed for the discharge. At channel expansion rates of 2 to 2.5 km/sec the radiation spectrum of the discharge column corresponds to that of a blackbody at temperature varying from 4 to 2 eV in 20 μsec. The discharge can be used as a high-intensity light source. (auth)

Kinetics (Theoretical)

Refer also to abstracts 48999 and 49205.

49144 (COO-1726-52) SCATTERING PROBABILITY OF FAST TEST PARTICLES IN A PLASMA. Husseiny, A. A.; Forsen, H. K. (Wisconsin Univ., Madison. Dept. of Nuclear Engineering). [1970]. 20p. Dep. CFSTI.

An effective total cross section is calculated for elastic scattering of a monoenergetic beam of test particles in a plasma of arbitrary velocity distribution. Closed-form solutions are obtained for the special case of Maxwellian field particles, taking into account small-angle scattering. The results are compared with those obtained using the Debye-cutoff technique, and it is shown that such an arbitrary cutoff can lead to erroneous results in the effective cross section and it can lead to different conclusions with regard to the relative importance of plasma ions and electrons in test-particle scattering. (auth)

49145 (COO-2059-2) NONLINEAR BEHAVIOR OF THE ONE-DIMENSIONAL BEAM PLASMA SYSTEM. Joyce, Glenn; Knorr, Georg; Burns, Thomas (Iowa Univ., Iowa City. Dept.

of Physics and Astronomy). [1970]. Contract AT(11-1)-2059. 21p. Dep. CFSTI.

The effect of a beam of electrons on a Maxwellian plasma is studied by integrating numerically the Vlasov equation in one dimension. The solution is carried past the point of maximum electrostatic energy. After reaching its maximum value, the electrostatic energy fluctuates about its maximum. Some modes that are linearly stable grow due to mode coupling with the unstable modes. The relative amount of energy in the fastest growing mode is shown to depend on the periodicity length of the system. (auth)

49146 (COO-2059-3) ADIABATIC ELECTRON PLASMA AND ITS EQUATION OF STATE. Knorr, G.; Nuehrenberg, J. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). May 1970. Contract AT(11-1)-2059. 21p. Dep. CFSTI.

For slow processes in a collisionless two-component plasma, which conserve the adiabatic invariant of the electrons, the equation of motion for electrons is derived. The conservation laws for the whole system are discussed in relation to the equation of state and a consistent distribution function for the electrons. (auth)

49147 (NYO-1480-139) NOTES ON CHARGE-NEUTRAL SELF-CONSISTENT PLASMAS AND FIELDS. Morawetz, Cathleen S. (New York Univ., N. Y. Courant Inst. of Mathematical Sciences). Jan 1970. Contract AT(30-1)-1480. 77p. (MF-60). Dep. CFSTI.

The Vlasov equations are reduced to a general form for solving initial-value problems. These equations are then studied from the point of view of type and of important scale lengths. It is noted that transverse flows depending on only one space variable depend on c/ω_{pe} for small mass ratio but c/ω_{pi} is the natural length for all other cases. Steady flows on a scale length c/ω_{pi} are studied as asymptotic limits. Estimates show that the fields and currents cannot grow faster than $c/\omega_{pe}A$ where A is Alfven speed, unless the electrons are hot. The time-dependent one-dimensional equations with transverse field are investigated by various methods. The asymptotic treatment of electrons is determined. Correctly posed problems for the initial-boundary value problems are discussed and also some limiting cases. This study is made in Lagrangian coordinates. The results of computations for weak Riemann problems where there is no breaking and rarefaction piston problem are presented, along with the methods involved and justifications for certain assumptions such as neglecting third moments. Finally, a model for strong shocks is presented. It is shown that under rather weak assumptions the final state is uniquely determined by the initial stage. (auth)

49148 (SINP-TH-68-3) CONDUCTIVITY OF A PLASMA IN A STEADY MAGNETIC FIELD. Pradhan, T.; Dasgupta, B. (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). 10 Jul 1968. 6p. Dep. CFSTI (U. S. Sales Only).

With the aid of techniques used previously (Phys. Rev., 160: 184(1967)), and without recourse to any approximation, the authors prove that $k_\mu k_\nu \sigma_{\mu\nu}(k,\omega)/k^2$ is independent of the magnetic field strength. The above expression is the invariant of the "wave-number and frequency-dependent" complex conductivity tensor $\sigma_{\mu\nu}(k,\omega)$. (auth)

49149 (SINP-TH-68-8) CORRELATIONS IN PLASMA. I. Dasgupta, Brahmananda; Dasgupta, Padmanabha (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). [nd]. 31p. Dep. CFSTI (U. S. Sales Only).

The correlations of fluctuation in electric field intensity and current density are derived for nonequilibrium isotropic plasma. The calculation is based on the ring approximation results of Balescu and Taylor. The results reduces to the results obtained by Rostoker in the special case when the velocity distribution function is Maxwellian at the initial time. (auth)

49150 (SINP-TH-68-9) VLASOV EQUATION IN A MAGNETIC FIELD. Dasgupta, Padmanabha; Dasgupta, Brahmananda (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). [nd]. 41p. Dep. CFSTI (U. S. Sales Only).

The derivation of the Vlasov kinetic equation, together with the screening function for a plasma in a uniform magnetic field, is discussed within the framework of the diagram technique of Prigogine and Balescu. The Van Kampen–Case eigenfunctions for magnetoplasma are obtained from the linearized Vlasov equation. These functions form a complete orthogonal set and their use may greatly simplify various magnetoplasma calculations. An application to a certain integral equation, obtained by Haggerty and de Sobrino in connection with the ring equation and calculation of correlations within magnetoplasma, is also discussed. (auth)

49151 (UCRL-50910) TIBRO-GENERAL. Knox, Richard (California Univ., Livermore. Lawrence Radiation Lab.). 19 Aug 1970. 61p. Dep. CFSTI.

TIBRO-GENERAL is a modified version of a well-established code frequently used by the Sherwood Division of the Lawrence Radiation Laboratory to calculate the precise trajectories of charged particles in dc magnetic fields. It is faster, easier to use, and more versatile than its predecessors. This report describes the TIBRO-GENERAL computer program, its basic operational elements and characteristics, and the mathematical model upon which it is based. TIBRO-GENERAL is written in LRL's Fortran 400 language and can be used directly on Control Data Corporation's 6600 and 7600 computers. Few changes are needed to convert this program to Fortran II language. (auth)

49152 MOTION OF NEWLY CREATED MAGNETOPLASMA. Zinn, John (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 13: 2524-31(Oct 1970).

The motion of a nonuniform collisionless plasma that is created at t = 0 in a region containing a magnetic field is considered. Approximate integrals are obtained for the electron and ion Vlasov equations coupled with Maxwell's equations. The results include expressions for the E and B fields, the electron and ion velocities, and the particle densities. The expression for the E field contains a smooth part equivalent to the sum of an ambipolar field and the $v \times B$ field associated with a steadily increasing drift velocity. In addition, there are large oscillatory terms with frequencies close to the plasma frequency. The B field is, in an average sense, frozen in the expanding plasma; however, it oscillates with the E field, and the oscillations become progressively stronger with time. In the framework of the approximations used, the oscillations grow without limit, until the approximations fail. (auth)

49153 NUMERICAL MODEL FOR A LOW-PRESSURE PLASMA IN A TOROIDAL MAGNETIC FIELD. Winsor, Niels Karl. Princeton, N. J.; Princeton Univ. (1969). 149p. University Microfilms Order No. 70-8397.

Thesis.

Many plasma physics experiments are concerned with the containment of a fully ionized gas in a toroidal magnetic field. The bulk plasma motion, the normal modes of oscillation and the process of resistive diffusion are described. A fluid model is developed and described by a force equation, generalized Ohm's Law equation, a quasi-neutrality condition, and the mass continuity equation. The Ohm's Law equation includes electron pressure gradient and Hall current terms and a scalar resistivity. The plasma pressure is taken small compared to the magnetic pressure. Only slow waves are treated, so the magnetic field configuration is assumed to be symmetrical about the major axis of the torus, and a procedure for solving the equations is obtained. The procedure is implemented in a computer program. The equations are treated mathematically as an initial-value problem, and a finite-difference approximation is constructed using an explicit differencing technique. The linear stability of this numerical scheme is demonstrated. For reasonable stellarator parameters, the initial data must include parallel velocities which reach ten percent of the ion sound speed. The material flux is approximately five times the Pfirsch–Schlüter rate, and it scales with temperature, magnetic field intensity, and magnetic field rotational transform, as predicted by Pfirsch and Schlüter. The time behavior includes the development of counterrotating plasma layers. Outside the region of maximum density gradient, the plasma rotates with one sense; inside, it rotates with the opposite sense. This behavior is explained in terms of asymmetries in the diffusion process. (TSS) (Diss. Abstr. Int., B)

49154 METHODS IN COMPUTATIONAL PHYSICS: ADVANCES IN RESEARCH AND APPLICATIONS. VOLUME 9. PLASMA PHYSICS. Alder, Berni; Fernbach, Sidney; Rotenberg, Manuel (eds.). New York; Academic Press Inc. (1970). 511p. $23.00.

Separate abstracts were prepared for each of the 10 individual chapters. (M.O.W.)

For abstracts of individual chapters see: 49155–49164.

49155 ELECTROSTATIC SHEET MODEL FOR A PLASMA AND ITS MODIFICATION TO FINITE-SIZE PARTICLES. Dawson, John M. (Princeton Univ., N. J.). Methods Comput. Phys.; 9: 1-28(1970).

The electrostatic sheet model is discussed in terms of the following: (1) the one-species model, (2) the numerical method for following the motion of the one-species, one-dimensional plasma, (3) numerical methods for solving the two-species sheet model, (4) noise and collisional phenomenon for the sheet model, and (5) collisional emission and absorption of longitudinal waves. Investigations with finite-size particles were made on the following:

(1) the finite-size particle model, (2) investigation of fluctuations about thermal equilibrium, (3) the weak cold beam for finite-size particles, and (4) use of different-size charges on the particles. 22 references. (M.O.W.)

49156 SOLUTION OF VLASOV'S EQUATION BY TRANSFORM METHODS. Armstrong, Thomas P. (Univ. of Kansas, Lawrence); Harding, Rollin C.; Knorr, Georg; Montgomery, David. Methods Comput. Phys.; 9: 29-86(1970).

Solutions are derived by using the Fourier–Fourier expansion, the Fourier–Hermite expansion, and an extension of the Fourier–Hermite expansion. Summaries of results are given for each. 59 references. (M.O.W.)

49157 WATER-BAG MODEL. Berk, Herbert L. (Univ. of California, Livermore); Roberts, Keith V. Methods Comput. Phys.; 9: 87-134(1970).

The following sections are included: (1) physical properties of step-function distributions, (2) numerical methods, (3) numerical stability of the leapfrog scheme, and (4) numerical experiment of the bump-on-tail instability. 26 references. (M.O.W.)

49158 POTENTIAL CALCULATION AND SOME APPLICATIONS. Hockney, R. W. (Langley Research Center, Hampton, Va.). Methods Comput. Phys.; 9: 135-211(1970).

Direct methods for potential calculations for physical systems such as plasmas, galaxies of stars, and fluid vorticity are described. Also described are iterative methods and convergence, the arbitrary force law, computer models, and applications in particle models. 44 references. (M.O.W.)

49159 MULTIDIMENSIONAL PLASMA SIMULATION BY THE PARTICLE-IN-CELL METHOD. Morse, R. L. (Los Alamos Scientific Lab., N. Mex.). Methods Comput. Phys.; 9: 213-39(1970).

The Particle-in-Cell (PIC) method is used for simulation of axisymmetric plasma guns such as the plasma focus and coaxial guns. The PIC method is then used in collisionless plasma simulation. The two-beam instability and axisymmetric plasma confinement by variable magnetic fields are studied in particular. 17 references. (M.O.W.)

49160 FINITE-SIZE PARTICLE PHYSICS APPLIED TO PLASMA SIMULATION. Birdsall, Charles K.; Langdon, A. Bruce; Okuda, H. (Univ. of California, Berkeley). Methods Comput. Phys.; 9: 241-58(1970).

The basic properties were investigated of a plasma consisting of finite-size particles (clouds) whose interactions are smooth at small separations. It was found that, when the cloud size is less than the Debye length, longitudinal waves and Debye shielding are nearly the same as for a "real" plasma, while collisional phenomena are much reduced. When the cloud size is increased above the Debye length, collisions and fluctuations rapidly disappear, but the plasma properties are much modified. 17 references. (M.O.W.)

49161 FINITE-DIFFERENCE METHODS FOR COLLISIONLESS PLASMA MODELS. Byers, Jack A. (Univ. of California, Livermore); Killeen, John. Methods Comput. Phys.; 9: 259-305(1970).

Numerical solutions of the Vlasov equation using one- and two-dimensional models are described. A linear model and a two-dimensional nonlinear model of low-β plasma are described using the guiding-center drift equations. 22 references. (M.O.W.)

49162 APPLICATION OF HAMILTON'S PRINCIPLE TO NUMERICAL ANALYSIS OF VLASOV PLASMAS. Lewis, H. Ralph (Los Alamos Scientific Lab., N. Mex.). Methods Comput. Phys.; 9: 307-38(1970).

A Lagrangian description of Vlasov plasmas is given in detail. The formulation includes the possibility of nonelectromagnetic potentials that can be velocity-dependent. It also includes the description of material media that exhibit a certain type of nonlinear polarizability or magnetizability. The derivation of approximation schemes from Hamilton's principle is discussed. Both Lagrangian and Hamiltonian formulations are presented, and the energy theorem is derived. The method is then specialized to the consideration of a finite number of particles, and classes of energy-conserving generalizations of the particle-in-cell method were obtained. The application of the variational method to the two-stream instability with a continuum of particles is then described. 14 references. (M.O.W.)

49163 MAGNETOHYDRODYNAMIC CALCULATIONS. Roberts, Keith V. (Culham Lab., Abingdon, Eng.); Potter, D. E. Methods Comput. Phys.; 9: 339-420(1970).

Magnetohydrodynamic computer calculations in one, two, and three dimensions were discussed. Calculations of the plasma focus experiment are discussed in some detail. Magnetohydrodynamic models and difference methods are discussed in particular. 92 references. (M.O.W.)

49164 SOLUTION OF THE FOKKER–PLANCK EQUATION FOR A MIRROR-CONFINED PLASMA. Killeen, John (Univ. of California, Livermore, Univ. of California, Davis); Marx, Kenneth D. Methods Comput. Phys.; 9: 421-89(1970).

The mathematical model of a plasma confined by magnetic mirrors is considered. The Fokker–Planck equation is given, and the boundary conditions for a plasma with a loss cone in velocity space are described. The time-dependent solution of the Fokker–Planck equations is considered for both ions and electrons in the case where the distribution functions are assumed to the isotropic in velocity space. The complete Fokker–Planck equation is next solved for the ions, including the collisional effects of the electrons on the ions. Next, the calculations are extended to include the addition of one space variable, namely a coordinate along magnetic field lines. Ion distributions, electron densities and temperatures, and the ambipolar potential are simultaneously calculated as a function of this coordinate. 25 references. (M.O.W.)

49165 STATIONARY DISTRIBUTIONS WHEN HIGH-ENERGY ELECTRONS ARE INJECTED INTO HYDROGEN PLASMA. Gustafson, Torsten; Nilsson, S. Bertil (Univ. of Lund, Sweden). Ark. Fys.; 40: 281-98(1970).

Electrons of high energy are injected at a constant rate into a hydrogen plasma. The energy distributions of electrons, positrons, and photons are in the steady state represented by three coupled Volterra integral equations. A special study is included of the Coulomb collision term in the kinetic equation for electrons. Numerical calculations are performed for a model of an unbounded plasma in which only Coulomb collisions, bremsstrahlung, and pair creation are considered. Energy distributions are computed for injection energies of 10^8, 10^9, and 10^{10} eV. (auth) (Sweden)

49166 HYDRODYNAMIC TRANSPORT EQUATIONS FOR A WEAKLY IONIZED PLASMA. Timofeev, A. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 140-3(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 192-7(Jan 1970).

The hydrodynamic approximation is applicable to the electron component of a weakly ionized plasma only if the elastic losses exceed substantially the inelastic losses when an electron collides with a neutral particle. In this case the hydrodynamic system of transport equations reduces to a modified diffusion equation for the electron density in which the electric field appears as a parameter. (auth)

49167 THEORETICAL INVESTIGATION OF THE FIRST-ORDER MAGNETIC SELF-STRICTION IN A LOW-PRESSURE MERCURY VAPOR ARC WITH REMOTE WALLS. Hoyaux, M. F. (Univ. of Pittsburgh). Appl. Sci. Res. (The Hague); 22: 185-200(May 1970).

The conditions of magnetic self-striction in an arc of finite length, not confined laterally by walls, are investigated with a recently developed theory of ambipolar diffusion in a magnetic field, including all first order corrections. Indications are given of how numerical predictions can be made; the case of mercury vapor is treated as an example, using earlier measurements of cylindrical arcs. (auth)

49168 RADIATION FROM A RING SOURCE AROUND A COMPRESSIBLE PLASMA COLUMN. Cheng, D. K. (Syracuse Univ., N. Y.); Chen, H. C. Appl. Sci. Res. (The Hague); 22: 259-72 (May 1970).

The electromagnetic waves and plasma oscillations excited by a magnetic current ring source around an infinitely long compressible plasma column are studied. The governing partial differential equations for the electromagnetic and plasma modes are first formulated. They are then converted to ordinary differential equations by means of the Fourier transformation. The fields outside the plasma column are composed of a surface wave part contributed by the poles on the path of integration and a radiated part arising from branch points. The far zone radiation field is evaluated by the method of steepest descent through a saddle point. The presence of the plasma column modifies the radiated electromagnetic field of the ring source, and the radiation pattern depends on the plasma parameters in a complicated way. (auth)

49169 MAGNETIC BUNDLES IN REACTING FLOWING PLASMA. Nardi, V. (Stevens Inst. of Tech., Hoboken, N. Y.). Phys. Rev. Lett.; 25: 718-22(14 Sep 1970).

An exact theory of plasma filaments observed in coaxial accelerators is derived from a steady-state ($\partial/\partial t = 0$) description of the three-dimensional flow of deuterium plasma. Ionization and recombination reactions are considered. Magnetic structure

of the filaments (bundles of helical field lines), density distributions, and flow field fit the experimental evidence. (auth)

49170 KINETIC COEFFICIENT FOR ELECTRON REFLECTION AT THE INTERFACE BETWEEN A WEAKLY IONIZED PLASMA AND AN ELECTRODE. Baksht, F. G.; Ivanov, V. G. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 158-62(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 218-24(Jan 1970).

The emission of an electron from a plasma to an electrode or from a solid into a vacuum leads to the loss of fast electrons from the distribution function and to a corresponding reduction in the emission current, which is equivalent to the introduction of a so-called "reflection coefficient" in the equation for thermionic-emission current from the plasma. If the plasma is in contact with a cathode, there is an analogous effect of reflection of electrons injected from the cathode into the plasma. The reflection coefficients were calculated earlier for the limiting cases of intense and weak reflection, in which the reflection coefficient r satisfies the conditions $1 - r \ll 1$ and $r \ll 1$, respectively. In the present paper, one considers intermediate values of r, and finds the dependence of r on the parameter $p = (\tau_\epsilon/\tau_p)^{1/2} (kT_k/E_0)^{1/2}$ for various electron temperatures T (here τ_ϵ and τ_p are the energy and momentum relaxation times, T_k is the cathode temperature, and E_0 is the height of the potential barrier at the plasma–electrode contact). (auth)

49171 BREMSSTRAHLUNG FROM A STEADY-STATE COAXIAL PLASMA LAYER. Rozanov, V. B. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 42-7(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 62-9(Jan 1970).

The steady state of a one-dimensional (infinite along z) coaxial plasma layer surrounding a central conductor through which a current is flowing in the direction opposite the plasma current is discussed in the magnetohydrodynamic approximation. Thermal equilibrium is set up in the layer through the removal of Joule heat by electron bremsstrahlung. The radiation spectrum, which is governed by the temperature of the matter and the optical thickness of the layer, is evaluated. This system may be promising for use as a radiation source for laser pumping. (auth)

49172 PROBLEM OF ELECTRIC ARC POSITIVE COLUMN IN GAS FLUX. Suksov, I. I. Teplofiz. Vys. Temp.; 7: 408-15 (May-Jun 1969). (In Russian).

An approximation solution was found for the problem of electric arc positive column in longitudinal laminar flow of a high-temperature gas around a tube without considering radiation. Dorodnitsyn-type variables were used and resolution was obtained by a modified integral method. The problem was reduced to an ordinary differential equation. The results were applied in calculations for air at atmospheric pressure and temperature up to 15,000°K. (tr-auth)

49173 DEVELOPMENT OF ULTIMATE LOCAL PERTURBATION OF ELECTRIC CONDUCTIVITY IN WEAK-CONDUCTING GAS FLOW IN MAGNETIC FIELD. Degtyarev, L. M.; Zakiyaz'minskii, L. A.; Kurdyumov, S. P.; Samarskii, A. A.; Sokolov, V. S.; Faborskii, A. P. (Inst. of Applied Mathematics, Moscow). Teplofiz. Vys. Temp.; 7: 471-8(May-Jun 1969). (In Russian).

The local perturbations of electric conductivity introduced into the steady flow of weakly conducting gas in a magnetic field were studied. The dynamics of nonstationary interactions of perturbations with the magnetic field is examined, and conditions for development of perturbations and formation of a self-sustaining high-temperature electric-conducting gas layer (T layer) are formulated. (tr-auth)

49174 EFFECT OF FINITE ION SIZE ON ELECTRON COLLISION FREQUENCY IN A PLASMA. Maev, S. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 438-43(Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 567-74(Mar 1970).

The effect on the electron collision frequency of the deviation of the field from a Coulomb field at small impact parameters is investigated. Expressions for the collision frequency and the limits of applicability of known expressions for the frequency of pure Coulomb collisions are obtained on the basis of simple models of the interaction of electrons and atomic fragments of ions. It is shown that the interaction with the atomic fragments plays the main role in the scattering of electrons by atoms at temperatures higher than about 200 eV. Noticeable deviations can also occur in the scattering of slow electrons (up to 5 eV) by heavy atoms. A new type of "hybrid" kinetic equation is proposed to take account of close collisions in a plasma. (auth)

49175 THERMALLY INHOMOGENEOUS POSITIVE COLUMN. Belousova, L. E. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 396-8(Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 512-15(Mar 1970).

The electron balance equation is solved in a positive column with the radial variation of the temperature taken into account by successive approximations using the Laplace transform. The dependence of the neutral gas temperature on the radius is assumed to be parabolic. The electron temperature is assumed to be constant along the radius of the column. It is shown that the nonuniformity of the neutral gas temperature has a weak effect on the radial distribution of the electrons and electron temperature. (auth)

49176 PLASMOID MOTION IN AN AXIALLY SYMMETRIC SPATIALLY PERIODIC MAGNETIC FIELD. Kaltykov, A. A.; Tereshin, V. I.; Chebotarev, V. V.; Khizhnyak, N. A.; Lysenko, O. E. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 359-65 (Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 466-74(Mar 1970).

The motion of a plasmoid in a magnetic field formed by a series of coils with oppositely directed integrated currents is investigated. The motion is considered in the small-plasmoid approximation. The integration of the equations of motion is carried out on a digital computer for different plasmoid parameters. The features of the motion and injection of a plasmoid into such a field are investigated. (auth)

Production

Refer also to abstract 49112.

49177 (IPP-4/3) SMALL SOLID HYDROGEN PELLETS MADE FOR PLASMA PRODUCTION BY LASER. Krause, H.; Sachsenmaier, P.; Salzmann, H.; Sigel, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb 1970. 14p. (In German). Dep. CFSTI (U. S. Sales Only).

An apparatus for producing small hydrogen pellets and injecting them into a vacuum is described. The diameter of the pellets is between 50 to 80 μ. The apparatus will be used for plasma production by evaporating the pellets with a giant pulse laser. (auth)

49178 CREATION MODEL OF THE BOSTICK PLASMOID IN MAGNETIC-FIELD-FREE SPACE. Butler, D. A. (Joslyn Manufacturing and Supply Co., Cleveland). J. Appl. Phys.; 41: 4517-25(Oct 1970).

A creation model was developed to interpret the behavior of Bostick plasmoids in the plane of the discharge. The plasmoids are formed by pulsed unidirectional current discharges across the electrodes of a button gun in vacuo (10^{-6} torr). The model is that of a vacuum arc which expands in the form of a thin, highly conducting torus by virtue of the interaction of the surge current with its self-induced magnetic field. When the current no longer flows, the plasma of the arc continues to move by virtue of its own inertia. The plasmoid speeds directly away from the button gun have been determined experimentally from time of arrival measurements to moveable electrostatic probes, and are found to increase monotonically from 20 to 100 km/sec for a corresponding source voltage range of 2.5 to 17.5 kV. The measured velocity v' of any point on the plasma which subtends an angle θ to the direction of forward motion at the button-gun source is given by $v' = \langle I \rangle (\alpha/\pi\rho)^{1/2} \cos\theta$, where $\langle I \rangle$ is the average surge current, ρ is the measured mass per unit length (line density) of the genetic plasmoid and α is a theoretically calculated constant. The line density ρ of the plasmoid has been shown theoretically to be a constant and its magnitude has been measured to be 10^{-9} kg/m and hence the mass M of the plasmoid is deduced theoretically to be given by: $M = \langle I \rangle \tau (\alpha\pi\rho)^{1/2}$, where τ is the duration of the current pulse. This formula predicts the plasmoid mass to increase from 0.05 to 0.2 μg for the current range of interest and the predicted mass is verified to within 16% by a novel experimental technique. (auth)

49179 CYCLOTRON RESONANCE PLASMA SOURCE WITH VARIABLE TEMPERATURE AND DENSITY PROFILES. Decker, J. F.; D'Amico, C. V. (Bell Telephone Labs., Inc., Whippany, N. J.). Rev. Sci. Instrum.; 41: 1431-3(Oct 1970).

A simple plasma source using microwave breakdown near cyclotron resonance in a low pressure gas was developed. It consists of a tapered glass tube inserted through a waveguide that is terminated by a tunable short. By suitable choice of the degree of taper, the problem of strong temperature inhomogeneities (and sometimes hollow plasmas) frequently encountered with ECR plasma production can be overcome. Using relatively low microwave power levels, < 3 W, the following ranges of electron temperatures and densities were produced: $2 < T_e < 8.5$ eV and $3 \times 10^9 < N_e < 4 \times 10^{10}$ cm^{-3} (the density is power limited). (auth)

Stability

49180 (TID-25531) THEORETICAL STUDY ON NONLINEAR INSTABILITIES IN PLASMA. Fukai, Junichiro (Tennessee Univ., Knoxville). Aug 1970. Contract AT(40-1)-2598. 77p. Dep. CFSTI.

Thesis.

Some nonlinear instabilities in plasma are investigated from a quantum mechanical point of view. This thesis consists of two parts: (1) explosive plasma instabilities and (2) plasmons and the linear and nonlinear two-stream instabilities. In order to provide necessary tools to discuss these problems, the second quantization formalism of particles in a magnetic field and the interaction Hamiltonian between particles and waves are reviewed. (M.O.W.)

49181 TEMPERATURE GRADIENTS, RESONANCE, AND THE INTERCHANGE INSTABILITY. Emmert, Gilbert A. (Univ. of Wisconsin, Madison). Phys. Fluids; 13: 2619-21 (Oct 1970).

Temperature gradients and wave-guiding-center resonance modify the usual finite gyroradius stabilization criteria and growth rate for the interchange instability in a collisionless low-β plasma. The growth rate is given for a few examples. (auth)

49182 RELATIVISTIC BEAM EQUILIBRIA WITH BACK CURRENTS. Benford, Gregory (Univ. of California, Livermore); Book, David L.; Sudan, R. N. Phys. Fluids; 13: 2621-3 (Oct 1970).

A generalization of the Bennett distribution leads to a hollowed-out beam with back currents. The system becomes more and more unstable to the resistive firehose mode as the beam is hollowed out. (auth)

49183 MICROINSTABILITIES IN INHOMOGENEOUS PLASMAS: THEORY. Beasley, C. O. Jr. (Oak Ridge National Lab., Tenn.); Farr, W. M.; Grawe, H. Phys. Fluids; 13: 2563-8(Oct 1970).

A formalism is presented for the determination of unstable electrostatic oscillations in a model mirror-confined plasma with a Gaussian density variation of arbitrary scale length along the magnetic field. A formal solution to the collisionless Boltzman equation is obtained for a plasma confined in a parabolic well. Using this solution, one may numerically solve Poisson's equation to obtain the eigenfunctions (perturbed potentials) and eigenvalues (densities) of the system for a given frequency and growth rate. As no mathematical limits on plasma length exist for obtaining these solutions, the infinite-plasma results may be recovered in the limit of very long plasmas. (auth)

49184 NONLINEAR THEORY OF THE POSITIVE COLUMN SPIRAL INSTABILITY. Shiau, J. N.; Simon, Albert (Univ. of Rochester, N. Y.). Phys. Fluids; 13: 2569-71(Oct 1970).

A previous calculation of the positive column spiral instability is extended to include mode-coupling terms as well as mixtures of He^+ and He_2^+. At any given pressure, the theoretical results for pure He^+ and for pure He_2^+ always bracket the experimental observation. The exact mixture necessary for agreement varies with pressure in the expected manner. (auth)

49185 FEEDBACK STABILIZATION OF A HIGH-β, SHARP-BOUNDARIED PLASMA COLUMN WITH HELICAL FIELDS. Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.); Rosenbluth, M. N. Phys. Fluids; 13: 2572-7(Oct 1970).

A sharp-boundaried, high-β stellarator of l-fold helical symmetry (plasma radius a, periodicity length $2\pi/h$) is magnetohydrodynamically unstable, particularly to the m = 1, long-wavelength mode. For this mode the instability is driven by $l \pm 1$ fields introduced by the unstable displacement ξ. Compensating fields (or, equivalently, plasma distortions) to counteract the instability can be introduced externally and controlled by a feedback arrangement. Estimates of the required external currents are given. The self-adjointness property of the magnetohydrodynamic energy-principle operator is used to derive the general relationship between the external fields and the unstable motion. Since perturbation theory is used, the question arises whether the normal mode with feedback differs appreciably from that without feedback for large feedback. The mode may be driven to a pure interchange, which is not subject to feedback control. In the stellarator this mode is stable above a critical β [of order $(ha)^2$ for $l = 1$], and linear feedback stabilization is apparently possible in this case. (auth)

49186 CRITERION FOR ABSOLUTE AND CONVECTIVE INSTABILITIES. Kotsarenko, N. Ya.; Fedorchenko, A. M. (Kiev State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 28-31(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 41-6(Jan 1970).

A criterion is obtained for the classification of instabilities as absolute or convective. The criterion is illustrated by the dispersion equation for three coupled waves. It is shown that the introduction of damping can convert an absolute stability into a convective instability. (auth)

49187 HYDROMAGNETIC STABILITY OF A CURRENT-CARRYING PINCH IN A STRONG LONGITUDINAL MAGNETIC FIELD. Shafranov, V. D. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 175-83(Aug 1970).

Translated from Zh. Tekh. Fiz.; 40: 241-53(Feb 1970).

Earlier work has been concerned with homogeneous and other special current distributions. It is shown here that for $B_z \gg B_\theta$ hydromagnetic perturbations that lead to instabilities can be separated into local flute modes and nonlocal perturbations of the surface-wave type. In plasmas with moving boundaries two types of perturbations predominate. The most important result is the possibility of completely stabilizing these perturbations for a sufficiently rapid reduction of current density with radius. Criteria for dissipative instabilities in Tokamak systems are also discussed. (auth)

49188 EQUILIBRIUM AND STABILITY OF A CURRENT-CARRYING PLASMA. Nagao, Shigeo (Tohoku Univ., Sendai). Technol. Rep. Tohoku Univ.; 35: 45-54(Jun 1970).

The equations of plasma equilibrium are solved exactly in the linear cylindrical coordinates (r, θ, z), when the conductivity of the current-carrying plasma column was considered finite. And it is shown that the magnetic field configurations in the equilibrium states are determined by the magnitude of the paramagnetic current driven by the axial electric field, relative to the diamagnetic current, due to the gradient of plasma pressure; in order to obtain the shear of magnetic field lines for the consideration of plasma stability, the wave form of axial magnetic field B_z which is applied externally at the wall of discharge tube $r = r_w$, should be somehow different from that of total axial current J_z (for example, $B_z = B_0 \cos \omega t$ for $J_z = J_0 \sin \omega t$). (auth) (Japan)

49189 INSTABILITY OF AN ELECTRON BEAM WITH A VELOCITY GRADIENT. Zhelyazkov, I. I.; Rukhadze, A. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 188-91(Aug 1970).

Translated from Zh. Tekh. Fiz.; 40: 259-64(Feb 1970).

A beam with a linear profile is used to examine the slipping-stream instability in a plasma. A general criterion for the instability is derived in terms of the external longitudinal magnetic field; an electron beam with such a profile is stable in the limit of very strong fields. A region of slipping-stream instability appears as the field is reduced, and the beam is always unstable if the external field is zero. The growth rates are derived for the longwave and shortwave regions in the presence of a magnetic field. (auth)

49190 STABILITY OF AN ISOLATED BOUNDED ELECTRON BEAM WITH A VELOCITY GRADIENT. Zhelyazkov, I. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 192-5(Aug 1970).

Translated from Zh. Tekh. Fiz.; 40: 265-9(Feb 1970).

A study was made of the stability of a plane-parallel electron beam with a velocity gradient which is bounded and isolated from metal walls. It is shown that such a beam can only be unstable with respect to long-wave oscillations having growth rates which are always smaller than the plasma frequency of the electrons. In this case a larger velocity gradient is required for instability than for a beam bounded by metal walls. Thus, the isolation of an electron beam stabilizes it to a certain extent. (auth)

49191 HYDRODYNAMIC THEORY OF THE STABILITY OF A DENSE STRATIFIED PLASMA STREAM. Baikov, I. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 328-34(Aug 1970).

Translated from Zh. Tekh. Fiz.; 40: 431-40(Feb 1970).

A two-fluid hydrodynamic model is used to investigate the stability of a dense inhomogeneous plasma stream moving along a strong magnetic field with a velocity which is a function of the cross section. A dispersion relation is obtained that determines the spectra of weak electrostatic oscillations of the plasma stream within the limits of geometric optics. It is shown that low-frequency instabilities arise due to the velocity gradients in the stream for phase resonance between the stream velocity and the sound speed or drift wave velocity in a dense collision-dominated plasma. The growth rates of these instabilities can be much larger than the drift frequency of the plasma. The effect of finite conductivity and viscosity on the growth of these oscillations is investigated. For large velocity gradients such instabilities are not stabilized by a small shear; hence, they

represent a danger to the magnetic confinement of the plasma stream and can lead to turbulence for stream velocities smaller than the Alfvén speed. (auth)

Thermonuclear Processes

Refer also to abstract 49048.

49192 (AEC-tr-7168) MAGNETIC FIELD AND HIGH-FREQUENCY INDUCTANCE OF NESTED TORUSES. Stotland, M. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). Translated from Preprint No. 1969-5. 13p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 24077. (M.O.W.)

49193 (UCRL-72309) SOME OBSERVATIONS ON THE RADIOLOGICAL ASPECTS OF FUSION. Lee, J. D. (California Univ., Livermore. Lawrence Radiation Lab.). 19 Aug 1970. 12p. (CONF-700912-1). Dep. CFSTI.

From 5th Annual Intersociety Energy Conversion Engineering Conference, Las Vegas, Nevada.

Most fusion reactions of interest produce fast neutrons. These neutrons are a source of both penetrating radiation and radioactive contamination due to activation. The amounts of radiation and contamination produced depend on both the fusion reaction employed and the type of neutron-intercepting blanket used. The analysis presented here is based on deuterium–tritium fusion, which produces 14.1-MeV neutrons, and a lithium–niobium, tritium-breeding blanket. Penetrating radiation consisting of primary fusion neutrons plus secondary and decay gammas produced in the blanket is roughly an order of magnitude greater than that produced in a fission reactor. Therefore, fusion reactors will require greater neutron and gamma shielding than fission reactors. An estimate of fusion's contamination hazard is based on activity levels of the blanket activation products, ^{3}T, ^{8}Li, ^{92}Nb and the two isomers of ^{94}Nb. These activity levels are weighted by their respective permissable concentration levels, summed and compared with a fission reactor's potential radiological contamination hazard calculated in a like manner. The DT fusion reactor is estimated to be both cleaner and easier to contain than a fission reactor operating at the same power level. (auth)

49194 (UCRL-72336) SOME ENGINEERING ASPECTS OF AN ASTRON FUSION POWER REACTOR SYSTEM. Lee, J. D.; Werner, R. W.; Myers, B.; Mohr, P. B.; Carlson, G. A.; Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Aug 1970. 8p. (CONF-700912-2). Dep. CFSTI.

From 5th Annual Intersociety Energy Conversion Engineering Conference, Las Vegas, Nevada.

Described here are engineering aspects of an updated version of an Astron power reactor. In addition to a general description, structural design, neutronics, heat transfer, and costs are discussed. The reacting deuterium-tritium plasma ($D + T \rightarrow {}^{4}He + n + 17.6$ MeV) is contained by the field pattern of closed magnetic lines unique to the Astron system. The neutronic calculations examine the trade-offs between tritium breeding and energy generation while including the influence of structural design and heat transfer requirements. The blanket is a niobium structure of modular design operating at a maximum temperature of 1150°K. A modular design of the blanket permits fabrication economies and allows for replacement of a relatively low-cost structural shell on a time schedule matched to radiation damage. The reactor is subdivided into two basic units: (1) a "throw away" portion of the blanket shell exposed to high flux fast neutrons, and (2) a long life, substantially zero-neutron environment containment vessel including shields, magnet structure, etc. The reactor total output including charged particle energy is ~12,000 MW_{total}, 5,000 MW_e net. (auth)

49195 DUOPLASMATRON-TYPE ION SOURCE INCLUDING A GAS RESERVOIR. Kelley, George G. (to United States Atomic Energy Commission). U. S. Patent 3,513,351. 19 May 1970. Filed 26 Jun 1968.

The effective volume of the region between the intermediate electrode and the anode of a duoplasmatron-type ion source is made large compared to that of the prior art to reduce current transients caused by ion pumping of the arc passing therethrough. This is effectively accomplished by providing an external reservoir that communicates with that region and, furthermore, by introducing the source gas into that reservoir. This source was developed for ion injection into thermonuclear devices. (auth)

49196 X-RAY SPECTRA FROM DENSE PLASMA FOCUS DEVICES. van Paassen, H. L. L. (Aerospace Corp., El Segundo, Calif.); Vandre, R. H.; White, R. Stephen. Phys. Fluids; 13: 2606-12(Oct 1970).

X-ray spectra with energies up to 350 keV are reported for two paraboloidal plasma focus devices, the Mark I and Mark III device. Low-energy x rays with energies between 5.46 and 29.2 keV were measured with Ross filters. Both time-resolved and time-integrated spectra were obtained. The higher-energy x rays from 60 to 350 keV were measured with K-5 nuclear emulsions. The energies of the individual electrons produced by the photoelectric effect and by Compton scattering in the nuclear emulsion were measured and the x-ray spectra were deduced. The x-ray spectra from each device can be represented by the function $(dN/dE)E = AE^{-m}$. In the Mark I device, $A = (0.85 \pm 0.28) \times 10^{8}$ ergs $(keV)^{1.5}$ and $m = (2.5 \pm 0.8)$; in the Mark III device, $A = (3.8 \pm 1.0) \times 10^{8}$ ergs $(keV)^{1.5}$ and $m = (2.5 \pm 1.0)$, where E is the photon energy in keV. Both spectra are similar in shape, but the x-ray intensity from Mark III, with four times the bank energy, is greater. The x rays appear to be produced by thick target bremsstrahlung on the anode surface by electrons with maximum energies greater than 350 keV and total energy distributions that vary as $E^{-3.5}$. The start of the x-ray pulse is found to be coincident in time with the current discontinuity in the plasma pinch device. (auth)

49197 POSSIBILITY OF PLASMA INJECTION INTO A CLOSED MAGNETIC TRAP THROUGH A DIVERTER. Georgievskii, A. V.; Biryukov, O. V.; Dikii, A. G.; Ziser, V. E.; Peletminskaya, V. G. This paper was summarized in At. Energ. (USSR); 24: 61-2(Jan 1968) as paper No. 177. (In Russian).

A method is proposed for injecting a plasma into a stellarator through a diverter using the fact that its magnet system extracts the lines of force from the trap. Here the plasma clusters passing through the vacuum chamber of the diverter will be freed from the accompanying neutral gas. The magnet system of the diverter is altered somewhat in order to move the plasma clusters over the entire path from the palsma source to the input of the trap in a uniform magnetic field parallel to the lines of force. Preliminary calculations and the results obtained from studying the magnetic field using electron beams showed that the fields are joined when $\delta = H_i/H_0 \leq 2$ (for angles of revolution of up to 22° for the adjusting coils). Here the cross section of the joining flux is deformed from a circle into an oval as one goes from a transverse to a longitudinal field. For a zero revolution angle for the adjusting coils joining takes place only when $\delta \geq 4$. (TSS)

49198 DENSE-PLASMA PULSED THERMONUCLEAR FACILITY. Alikhanov, S. G.; Kichigin, G. N.; Konkashbaev, I. K. This paper was summarized in At. Energ. (USSR); 25: 45-6(Jul 1968) as paper No. 210. (In Russian).

The range of possible variants of thermonuclear systems with coordinates N (total number of particles) and n (plasma density) satisfying the Lawson criterion is shown and is bounded by the maximum permissible energy yield (TNT equivalent 100 kg) the maximum density, viz. density of a solid, and the time of free flight. Two straight lines separate the region $N > f(n)$ where reactors featuring Bohm diffusion can be designed, from the rest. This region has received little study, but is of definite interest in view of the possibility, in principle, of achieving pulsed thermonuclear reactors, since heating, stability, equilibrium, and confinement are problems that are solvable for such systems at the present level of understanding of plasma physics and the possibilities achievable at the present state of the art. (TSS)

49199 STUDY AND DEVELOPMENT OF A MICROWAVE CIRCULAR POLARIZER. Deschamps, J.; Fitaire, M.; Pagnon, D. (Paris Univ., Orsay, France). Rev. Phys. Appl.; 5: 283-6(Apr 1970). (In French).

A special fabrication technique was used to construct a high-frequency S-band (3000 MHz) circular wave polariser. The circularly polarized wave was obtained by sending two linearly polarised waves through a waveguide with elliptical cross section, the polarization of each wave being parallel to one of the principal axes of the ellipse. The fabrication technique used yielded an elliptical cross section with a smooth transition to a cylindrical guide. The resulting polariser supported very high power levels (up to 23 MW). A special microwave assembly preceding the polariser yielded a circularly polarized wave regardless of the S.W.R. of the termination. (France)

49200 SPARK GAP POWER SWITCHING FOR CONICAL theta-PINCH PLASMA GUN. Kuswa, Glenn; Stallings, Charles (Univ. of Wisconsin, Madison). Rev. Sci. Instrum.; 41: 1429-30(Oct 1970).

A simple, easily maintained air spark gap of ~7 nH inductance was developed to switch 0.24 C stored charge at 20 kV in an LC circuit having a period of ~4 μsec. A similar 3 nH spark gap with an auxiliary triggering circuit was used to clamp the magnetic

flux within the load near the voltage minimum. Voltages up to 30 kV and currents to 5×10^5 A were handled. Acoustic noise was minimized by completely enclosing the arc, and forced air venting removed corrosive gases and helped control the temperature to improve reproducibility. (auth)

49201 CHARACTERISTICS OF PLASMA ACCELERATION IN ELECTROMAGNETIC ACCELERATORS WITH DIELECTRIC EROSION. Balagurov, A. Ya.; Grishin, S. D.; Levtov, V. L.; Leskov, L. V.; Mikhalev, V. G.; Petrov, A. M.; Savin, A. F.; Savichev, V. V.; Chivilev, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 345-51(Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 450-7(Mar 1970).

A study is made of the features of the formation and acceleration of plasma in pulsed electromagnetic accelerators having rail and coaxial geometry and erosion of dielectrics. The energy loss at the accelerator electrodes is investigated. A functional dependence on accelerator geometry and circuit parameters is determined for the plasmoid monochromaticity factor. A method for approximate calculation of the monochromaticity factor is developed. (auth)

49202 PULSED TWO-STAGE PLASMA ACCELERATOR. Balagurov, A. Ya.; Grishin, S. D.; Ershov, A. G.; Leskov, L. V.; Petrov, A. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 352-4(Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 458-61(Mar 1970).

A pulsed two-stage coaxial plasma accelerator in which the triggering of the discharge is accomplished by introducing an additional electrode is investigated. It is shown that the acceleration efficiency depends on the length of the additional electrode. (auth)

49203 CURRENT DISTRIBUTION IN A PULSED PLASMA ACCELERATOR WITH DIELECTRIC EROSION. Kalygin, A. G.; Kozlov, N. P.; Leskov, L. V.; Saenko, V. B. (Moscow Technological Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 355-8(Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 462-5(Mar 1970).

A rail accelerator with dielectric erosion is investigated. The presence of two plasmoids subject to electrodynamic acceleration is established. Current flow over the dielectric surface is recorded throughout the discharge. (auth)

Wave Phenomena

Refer also to abstract 49278.

49204 MAIN ELECTRON RESONANCE OF A BOUNDED PLASMA AT HIGH MAGNETIC FIELDS. Messiaen, A. M.; Vandenplas, P. E. (EURATOM-ETAL Belge, Brussels). Phys. Fluids; 13: 2590-2(Oct 1970).

The main electron resonance, whose behavior up to $\omega_{ce}/\omega \simeq 1$ is well understood, was experimentally followed up to high magnetic fields ($\omega_{ce}/\omega \simeq 50$) in a very quiet plasma. There is very good agreement with recent theoretical predictions based on the hydrodynamical description of a bounded, hot, electron-ion plasma, thereby confirming, for the values of the plasma parameters involved, the validity of the theory used. (auth)

49205 ION ACOUSTIC WAVE EXCITATION AND ION SHEATH EVOLUTION. Widner, M. (Oak Ridge National Lab., Tenn.); Alexeff, I.; Jones, W. D.; Lonngren, K. E. Phys. Fluids; 13: 2532-40(Oct 1970).

A series of computer simulations and experiments were performed to investigate the time evolution of an ion space-charge sheath from a solid electrode in a plasma. A large negative step potential ($e\Delta V \gg kT_e$) is applied to the boundary of a uniform plasma and the response computed. A fluid model is used for cold ions, and hot electrons in thermal equilibrium are assumed as a neutralizing background. Both the computer simulations and the experiments show the formation of an ion space-charge sheath in a few ion plasma periods and a rarefying disturbance propagating into the plasma with the ion-acoustic speed. For a plane electrode this disturbance extends to the electrode, resembling a rarefaction wave as found in ordinary fluid dynamics. For cylindrical and spherical electrodes this disturbance breaks away from the sheath and propagates as an ion-acoustic wave into the plasma. The addition of substantial ion-neutral collisions is found to prevent separation of the wave from the sheath. The results of the computer simulations and the experiments agree. (auth)

49206 EFFECTS OF BUNCHED ION BURSTS ON APPARENT NONLINEAR ION ACOUSTIC WAVES. Ichikawa, Yoshi H. (Univ. of Iowa, Iowa City). Phys. Fluids; 13: 2541-45(Oct 1970).

The bunching effects of ions at the excitation grid in a typical ion-acoustic wave experiment are examined by applying the generalized quasi-linear theory of Al'tshul and Karpman to a simple model of the grid-plasma system. The resulting bunched ion bursts exhibit amplitude modulation at a distance far from the grid. The characteristics of this amplitude modulation appear to be similar to the recently observed results of Sato, Ikezi, Takahasi and Yamashita, who interpreted their results in terms of nonlinear Landau damping of ion-acoustic waves. (auth)

49207 SPATIAL DAMPING OF LARGE AMPLITUDE WAVES. Lee, A.; Schmidt, G. (Stevens Inst. of Tech., Hoboken, N. J.) Phys. Fluids; 13: 2546-53(Oct 1970).

The spatial damping of a large-amplitude plasma wave was studied to permit direct comparison with experimental data. Using both the quasi-linear treatment of Al'tshul and Karpman, and following exact particle trajectories of resonant particles as done by O'Neil for the temporal case, it was found that the spatial damping results are analogous to the temporal ones. The spatial damping formula is obtained by replacing the nondimensional time t/τ and damping coefficient $\gamma_L\tau$ for the temporal case by the distance x/L and spatial damping coefficient $\Lambda_L L$, respectively. Here, $\tau = (m/eEk)^{1/2}$, γ_L is the linear Landau damping coefficient, $\Lambda_L = [(\gamma_L)/(\partial\omega/\partial k)]$, and $L = \tau\omega/k$. Damping curves have been plotted for comparison with measured data. The validity condition of the spatial case, namely, $\Lambda_L L \ll 1$, is far more stringent than for the temporal one. (auth)

49208 NONLINEAR LANDAU DAMPING OF ION ACOUSTIC MODES. Sloan, M. L.; Drummond, W. E. (Univ. of Texas, Austin). Phys. Fluids; 13: 2554-62(Oct 1970).

The time development of the ion-acoustic modes of a hot electron plasma drifting through a cold ion beam is investigated. The nonlinear dynamics of the wave are governed by nonlinear Landau damping, resonant wave-wave scattering being forbidden. Owing to the adiabatic nature of the electrons, nonlinear Landau damping on the electrons is the dominant nonlinear process rather than ion nonlinear damping, contrary to the results of Kadomtsev. This error brings the anomalous resistivity formula of Sagdeev into serious question. (auth)

49209 WAVE PROPAGATION IN PARTLY IONIZED VISCOUS PLASMAS. Morin, Stephen; Kahn, David (Electronics Research Center, Cambridge, Mass.). Phys. Fluids; 13: 2499-2507(Oct 1970).

An analysis of longitudinal wave propagation in partially ionized, viscous plasmas is presented. Equations of motion for the three plasma constituents (electrons, ions, and neutrals) are formulated from a coupled set of Maxwell and Boltzmann equations. It is found that under suitable conditions all three plasma wave modes (neutral, ion, and electron waves) can be unstable. (auth)

49210 EXPERIMENTAL INVESTIGATIONS OF A STREAMING PLASMA COLUMN AT LOW MAGNETIC FIELDS. Cataldo, Joseph C. (City Coll., New York). Phys. Fluids; 13: 2508-13 (Oct 1970).

An experimental study of a low-β surface-ionized streaming plasma column is presented for low magnetic fields. As the magnetic field is lowered to 400 G, a hollow plasma column sets in and edge oscillations are suppressed. At 175 G a distinct cellular pattern is observed by plasma camera photographs. Below 100 G a hollow plasma column with larger inner and outer diameters reappears. These lower magnetic field phenomena result in an order of magnitude increase in the plasma density. The large increase in density was always accompanied by a change in the ionizer sheath conditions, from ion to electron, as the magnetic field was lowered below 400 G. (auth)

49211 ELECTROMAGNETIC WAVE SCATTERING WITHIN A PLASMA IN THE TRANSPORT APPROXIMATION. Watson, Kenneth M. (Univ. of California, Berkeley). Phys. Fluids; 13: 2514-23(Oct 1970).

The radiation transport equation is studied as a means of describing the scattering of electromagnetic waves by a plasma. The approximations required to replace Maxwell's equations by a transport equation are reviewed. The form of the transport equation expressed in terms of Stokes' parameters is given and special expressions for backscatter are developed. (auth)

49212 INSTABILITY OF ENTROPY WAVES DUE TO THE GYRO-RELAXATION EFFECT IN A FINITE PRESSURE PLASMA. Mikhailovskii, A. B.; Tsypin, V. S. Zh. Eksp. Teor. Fiz.; 59: 584-93(Aug 1970). (In Russian).

It is demonstrated that entropy waves are unstable due to the gyro-relaxation effect in a certain range of positive values of $\partial \ln n_0/\partial \ln p_0$ and in particular for $\nabla T_0 = 0$; in this case, perturbations for which the phase velocity magnitude and direction are

of the same order of magnitude as the electron magnetic drift velocity are unstable. The process cannot be correctly investigated by means of well-known hydrodynamic equations; therefore, in order to describe it on basis of the solution of the Boltzmann kinetic equation, a new set of macroscopic equations for the plasma is derived. (auth)

49213 NONLINEAR EFFECTS DUE TO TRANSVERSE WAVES IN A STATISTICAL PLASMA. Chakraborti, B. (Jaipur Univ., India). Zh. Eksp. Teor. Fiz.; 59: 457-63(Aug 1970). (In Russian).

The nonlinear Vlasov plasma equations are solved, ignoring collision terms, up to the third order in a perturbation that is a transverse wave in a neutral isotropic plasma. The second-order solution consists of a longitudinal second harmonic and a steady stream along the wave vector. In the initial-value problem the increment to the frequency, and in the boundary-value problem the increment to the wave vector, occur in the third-order solution; the two increments are different in the two planes of elliptic polarization. Transverse waves possessing eight different frequencies are obtained. The wave number shift leads to nonlinear deflection of the reflected radiation at the boundary between the plasma and nonplasma regions. For zero increment, four of the arguments yield the first harmonic and the other four the third harmonic. In the third-order approximation, this results in splitting of the single elliptically polarized wave into two plane-polarized waves of different phase and group velocities. The frequency shift is towards the red side. Numerical calculations for the Moessbauer nucleus ^{57}Fe show that the relative frequency shift is only of the order of 10^{-23}. (auth)

49214 MECHANISM OF FORMATION OF A HOT ELECTRON COMPONENT IN THE INTERACTION BETWEEN AN ELECTRON BEAM AND PLASMA. Karkhov, A. N. Zh. Eksp. Teor. Fiz.; 59: 356-65(Aug 1970). (In Russian).

Results are presented of an experimental investigation of the spectra of oscillations excited by an electron beam in a plasma under conditions when a hot electron component appears. It is shown that the oscillation spectra observed near the electron gun appreciably differ from those measured in other regions of the plasma in which waves of the "whistling atmospheric" type have been recorded. Absorption of waves of this type by cold plasma electrons and electrons of the hot component is detected. A mechanism of formation of the hot electron component is proposed on the basis of a generalization of the experimental results. It includes, as essential elements, scattering of beam electrons by the electrostatic oscillations, capture of part of the electrons by the magnetic traps, and their subsequent heating during resonance interaction with waves of the "whistling atmospheric" type. (auth)

49215 ANOMALOUS ABSORPTION OF CYCLOTRON WAVES IN A BOUNDED PLASMA. Bogdankevich, L. S.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 6-10(Jul 1970).
Translated from Zh. Tekh. Fiz.; 40: 10-17(Jan 1970).

The absorption of electron-cyclotron waves in a bounded tenuous plasma is investigated under conditions in which the electron gyrofrequency is considerably higher than the plasma frequency. In a spatially unbounded plasma, under these conditions, extraordinary cyclotron waves are strongly absorbed; at the same time, the ordinary waves experience practically no absorption. In a bounded plasma (e.g., a waveguide filled with plasma) because of the interaction of the waves at the boundary of the plasma, absorption of the ordinary waves can become anomalously large if the wavelengths are of the order of the plasma dimensions. In this case the absorption coefficient is an oscillating function of the wavelength and the dimensions of the system. Both a high-temperature collisionless plasma and a cold plasma with a high collision rate are studied. Recent experiments on absorption of cyclotron waves in bounded plasmas are discussed in terms of this analysis. (auth)

49216 NONLINEAR INTERACTION OF WAVES AT THE BOUNDARY OF A MAGNETOPLASMA. Alanakyan, Yu. R. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 48-52(Jul 1970).
Translated from Zh. Tekh. Fiz.; 40: 70-6(Jan 1970).

The nonlinear interaction of plane waves in a semiinfinite magnetoplasma is examined. Fields generated at the hybrid frequencies are found. When hybrid-frequency surface waves are generated, their amplitudes increase with time. (auth)

49217 NONLINEAR INTERACTION OF LONGITUDINAL WAVES IN A NONISOTHERMAL PLASMA. Bodyanitskii, A. A.; Repalov, N. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 21-7(Jul 1970).
Translated from Zh. Tekh. Fiz.; 40: 32-40(Jan 1970).

Equations were obtained that describe the amplitudes and the phase of interacting ion-acoustic and plasma oscillations in a nonisothermal plasma. The interaction of a low-frequency ion-acoustic wave with a discrete number of high-frequency plasma waves was investigated using these equations in three different cases, i.e., a finite number of plasma waves, two plasma waves with different phases, and a finite number of coherent plasma waves. Using these results, the characteristic times for such nonlinear interactions were compared, the amount of energy transferred from the plasma oscillations to the ion-acoustic waves was estimated, and the criteria for the onset of turbulence were established. (auth)

49218 NONLINEAR EXCITATION OF PLASMA OSCILLATIONS AT ELECTRON RESONANCE. Livshits, M. A.; Tsytovich, V. N. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 11-20(Jul 1970).
Translated from Zh. Tekh. Fiz.; 40: 18-31(Jan 1970).

The nonlinear interaction of a plasma with high-frequency fields whose frequency is near the electron gyrofrequency is considered. The kinetic nonlinear generation of waves in a plasma located in a strong magnetic field $\omega_{H_e} \gg \omega_{0_e}$ is studied. The nonlinear theory of cyclotron plasma heating is also considered. (auth)

49219 ABSORPTION OF MICROWAVE POWER BY A PLASMA AT MAGNETIC FIELDS ABOVE THE CYCLOTRON FIELD. Budnikov, V. N.; Golant, V. E.; Obukhov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 97-100(Jul 1970).
Translated from Zh. Tekh. Fiz.; 40: 138-41(Jan 1970).

The conditions were determined for which a plasma can be maintained by means of a microwave field for magnetic fields stronger than the cyclotron field and electron densities greater than the critical density, i.e., $H_c < H < 3H_c$ and $n_c < n < 15n_c$. The experiment was performed in argon at pressures of $10^{-1} - 10^{-3}$ mm Hg. The investigations were carried out with a constant source of microwave power in the 10-cm range at a level of 100 W. The plasma is generated under electron-cyclotron resonance conditions by means of an additional pulsed source of microwave energy in the 3-cm range. It is shown that the extent of the region in which the plasma exists is determined by the conditions of absorption of electromagnetic waves as governed by a linear transformation effect. (auth)

49220 ALFVEN WAVES IN AN INHOMOGENEOUS PLASMA WITH FINITE PRESSURE. Gurovich, V. Ts.; Naidorf, B. Yu.; Fridman, A. M. (Novosibirsk State Univ., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 337-9(Sep 1970).
Translated from Zh. Tekh. Fiz.; 40: 441-4(Mar 1970).

An inhomogeneous collisionless plasma at finite pressure with $\beta < 1$ is unstable for Alfvén waves in a narrow range of the temperature gradient for frequencies $|\omega| < |k_z|V_{Ti}$. (auth)

49221 WAVE TRANSFORMATION ON THE BOUNDARY OF THE PLASMA. Kondratenko, A. N.; Onishchenko, I. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 284-6(Aug 1970).
Translated from Zh. Tekh. Fiz.; 40: 384-7(Feb 1970).

The coefficients for transformation of longitudinal waves into transverse waves and transverse waves into longitudinal waves at a plasma-vacuum boundary are found with and without a constant magnetic field perpendicular to the boundary. The field, when present, is of such a strength that electrons are strongly affected. The transformation coefficients are shown to depend on the strength of the magnetic field and the angle of emission (incidence) of the waves into the vacuum. For high-frequency waves the transformation coefficient has a maximum for small emission angles; for low-frequency waves the coefficient is a maximum for angles near 180°. (auth)

49222 LINEAR WAVE TRANSFORMATION AND ABSORPTION IN PLASMA OF SMALL TRANSVERSE DIMENSIONS. Golant, V. E.; Krivosheev, M. V.; Fedorov, V. I. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 282-3(Aug 1970).
Translated from Zh. Tekh. Fiz.; 40: 382-4(Feb 1970).

Results of an experimental and theoretical investigation of the propagation of electromagnetic waves through a waveguide partially filled with plasma are given. The plasma in a positive column was investigated in the absence of a magnetic field and with a magnetic field. Satisfactory agreement is obtained between the experimental and predicted data on microwave absorption in the plasma, assuming that the observed absorption is due to a linear wave transformation in an inhomogeneous plasma. (auth)

49223 SCATTERING OF ELECTROMAGNETIC WAVES ON ELLIPSOIDAL PLASMA FORMATIONS IN THE ATMOSPHERE. Lysenko, O. E.; Khizhnyak, N. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 366-70(Sep 1970).
Translated from Zh. Tekh. Fiz.; 40: 475-81(Mar 1970).

The scattering of electromagnetic waves on ellipsoids with arbitrary electric and magnetic anisotropies is analyzed. By expansion of the interior fields in the parameter $a/\lambda < 1$ (a is the dimension of the ellipsoid; λ is wavelength of the scattered wave) the determination of the expansion coefficients is reduced to the solution of a system of linear algebraic equations. A method for setting up these equations is developed. Expressions for the interior fields and the fields in the wave zone are obtained with an accuracy up to and including terms of order $(a/\lambda)^2$. An expression for the differential scattering cross section is derived. The leading terms have the same form as in the scattering of a wave on a sphere. The ellipsoidal nature of the object appears in terms of order $(a/\lambda)^2$. (auth)

49224 RADIO-WAVE TRANSMISSION THROUGH A PLASMA IN AN INHOMOGENEOUS MAGNETIC FIELD. Brodskii, V. B.; Belitskii, B. M.; Anashkin, O. P.; Konyakhin, V. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 387-91 (Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 502-7(Mar 1970).

The transmission of radio waves through a magnetized plasma is measured as a function of the density and the electron collision frequency for densities of 10^{12} sec^{-1}. The plasma is produced by a coaxial accelerator and passes through an inhomogeneous magnetic field of 10 kOe created by a superconducting electromagnet. (auth)

49225 MICROWAVE FIELD DISTRIBUTION IN A PLASMA WAVEGUIDE. Egorov, A. M.; Kivshik, A. F. (Physical-Technical Inst., Karkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 392-5 (Sep 1970).

Translated from Zh. Tekh. Fiz.; 40: 508-11(Mar 1970).

The radial distribution of a microwave field in a plasma waveguide in an external longitudinal magnetic field and a metal chamber casing is investigated experimentally for an input microwave power $P_{in} = 1.5$ MW at 10 cm. The results are compared with linear theory. (auth)

Shielding

Refer also to abstracts 49680 and 50097.

49226 (GA-9904) FIPERX: A FORTRAN V PROGRAM FOR THE SOLUTION OF ONE-DIMENSIONAL LINEAR AND NON-LINEAR DIFFUSION PROBLEMS. Forutanpour, B.; Roos, B. (Gulf General Atomic, Inc., San Diego, Calif.). Sep 1969. Contract AT(04-3)-167. 187p. Dep. CFSTI.

A Fortran V program is presented for the solution of boundary-value problems involving systems of linear and/or nonlinear diffusion equations. The equations are solved for one-dimensional slabs, cylinders, and spheres. (M.H.R.)

49227 (LA-4287) BIBLIOGRAPHY ON NEUTRAL PARTICLE TRANSPORT THEORY. Hendry, W. L.; Lathrop, K. D.; Vandervoort, Sue; Wooten, John (comps.) (Los Alamos Scientific Lab., N. Mex.). Jun 1970. Contract W-7405-eng-36. 182p. Dep. CFSTI.

This report contains 1849 references to the technical literature on neutral particle (mostly neutron) transport theory. Two listings are included: one by author and one by subject. (auth)

49228 (ORNL-4585) MORSE CODE: A MULTIGROUP NEUTRON AND GAMMA-RAY MONTE CARLO TRANSPORT CODE. Straker, E. A.; Stevens, P. N.; Irving, D. C.; Cain, V. R. (Oak Ridge National Lab., Tenn.). Sep 1970. 314p. Dep. CFSTI.

The MORSE code is a multipurpose neutron and gamma-ray transport Monte Carlo code. Through the use of multigroup cross sections, the solution of neutron, gamma-ray, or coupled neutron-gamma-ray problems may be obtained in either the forward or adjoint mode. Time dependence for both shielding and criticality problems is provided. General three-dimensional geometry, as well as specialized one-dimensional geometry descriptions, may be used with an albedo option available at any material surface. Standard multigroup cross sections such as those used in discrete ordinates codes may be used as input; either ANISN or DTF-IV cross-section formats are acceptable. Anisotropic scattering is treated for each group-to-group transfer by utilizing a generalized Gaussian quadrature technique. The modular form of the code with built-in analysis capability for all types of estimators makes it possible to solve a complete neutron-gamma-ray problem as one job and without the use of tapes. A detailed discussion of the relationship between forward and adjoint flux and collision densities, as well as a detailed description of the treatment of the angle of scattering, is given in the appendices. Logical flow charts for each subroutine add to the understanding of the code. (auth)

49229 (ORNL-RSIC-11(Rev.2)) BIBLIOGRAPHY, SUBJECT INDEX, AND AUTHOR INDEX OF THE LITERATURE EXAMINED BY THE RADIATION SHIELDING INFORMATION CENTER (SPACE AND ACCELERATOR SHIELDING). Gurney, J.; Gustin, Ann B. (eds.) (Oak Ridge National Lab., Tenn.). May 1970. 109p. Dep. CFSTI.

Supersedes ORNL-RSIC-11(Rev.1).

The following subjects are covered: space radiation sources, cross-section data, particle transport, and shielding. (M.H.R.)

49230 (ORNL-tr-2112) INCREASE OF DOSE RATE BY ERECTION OF A RADIATION SHIELD. Sauter, E. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Atompraxis; 14: 426-8(1968). 4p. Dep. CFSTI.

An abstract of the original German article appeared in NSA 23: 533.

49231 (ORNL-tr-2360) NUCLEAR SHIELDING CALCULATIONS. NOTE NO. 6. ALTRAN CODE: CALCULATION OF NEUTRON TRANSMISSION AND REFLECTION IN SHIELDS BY THE MONTE CARLO METHOD. (Ministere des Armees, Paris (France). Direction Technique des Armements Terrestres). Translated for Oak Ridge National Lab., Tenn., from French report. 42p. Dep. CFSTI.

A neutron scattering calculation by a Monte Carlo method is described. The object is to obtain an angular flux and dose distribution due to neutrons reflected and transmitted by a slab of a given material. Gamma radiation produced by inelastic doses or neutron radiation in the material are neglected. The method of calculation, the computer programs, and flow charts are described. (M.H.R.)

49232 NEW METHOD FOR SOLUTION OF THE TRANSPORT EQUATION IN SLAB GEOMETRY. Erdoes, P. (Florida State Univ., Tallahassee); Haley, S. B.; Marti, J. T.; Mennig, J. J. Comput. Phys.; 6: 29-55(Aug 1970).

A new method, called the method of analytic angles, is developed for the solution of the transport equation (Boltzmann integro-differential equation) in slab geometry. The essence of the method is the discretization of the spatial variable accompanied by an analytic solution for the resulting difference equation with respect to the angular variable. This contrasts to other procedures such as the spherical harmonic, Wick-Chandrasekhar, and Carlson's S_N method, which are restricted to a finite number of values of the angular variable. Two examples are worked out. One is the phonon transport in solids with randomly distributed scattering centers. Here the numerical solution agrees very well with the asymptotic analytical solutions. The other example, a neutron transport problem, allows comparison with the S_N method, and indicates the excellence of the solution. (auth)

49233 ENERGY AND SPACE DISTRIBUTION OF BACK-SCATTERED γ-RADIATION. Zol'nikov, P. P.; Sukhanova, K. A.; Dvinyaninov, B. L. This paper was summarized in At. Energ. (USSR); 25: 518(Dec 1968) as paper No. 250. (In Russian).

Results of calculating the energy and space distribution of γ radiation reflected from semi-infinite barriers of lucite, aluminum, and lead are given for incident energy of 1 to 30 MeV. The contribution of Compton scattered γ quanta in the reflected radiation was calculated by the Monte Carlo method on an electronic computer. The annihilation radiation was determined by calculating the density of sources of annihilation γ quanta and their attenuation by the medium under discussion. On the basis of the resulting data for separate energy lines, a calculation was made of the energy spectrum of the reflected radiation for the case where the primary radiation is bremsstrahlung with boundary energies of 10, 15, and 25 MeV. An analysis is given of the basic physical laws governing the formation of the spectrum of the reflected radiation as a function of energy of the primary radiation, angle of detection, material, and thickness of the reflector. Graphs showing the number of annihilation γ-quanta in the reflected radiation as a function of the energy of the primary γ-quanta in the material in the reflective barrier are given. Previous data are given for comparison, where the spectra of the reflected radiation were calculated for barriers made of concrete. Here the calculation is made of contributions of annihilation γ quanta in the reflected radiation (in percent) for different radiators in the case of betatron bremsstrahlung with different boundary energy. It is shown that the energy distribution of betatron γ radiation reflected from plain barriers depends weakly on the maximum energy of the primary radiation. (auth)

49234 SPATIAL, ANGULAR, AND ENERGY DISTRIBUTIONS OF FAST NEUTRONS IN LITHIUM HYDRIDE, WATER, TUNGSTEN, AND BORON CARBIDE. Degtyarev, S. F.; Suvorov, A. P.; Tarasov, V. V.; Tikhonov, V. K.; Tsypin, S. G. This paper was

summarized in At. Energ. (USSR); 24: 372(Apr 1968) as paper No. 192. (In Russian).

Results of measurements of spatial, angular, and energy distributions of neutron fluxes in the energy range 0.5 to 10 MeV made with a fast neutron scintillation spectrometer, a long counter, and a fast (E > 1 MeV) neutron counter are presented for lithium hydride of density 0.5 g/cm^3, water, tungsten of density 17.4 g/cm^3, and boron carbide of density 1.3 g/cm^3 up to thickness of 60, 45, 15.4, and 50 cm respectively. Calculations of spatial, angular, and energy distributions of neutron fluxes in slab geometry for an infinite plane monodirectional beam of neutrons incident on the material were performed with the ROZ program in the $2P_7$ approximation, based on a modification of the method of discrete ordinates, using the principle of invariance. The results of the experiments and the calculations of angular distributions of fast neutron fluxes for lithium hydride slabs 45 and 60 cm thick are shown. The fast neutron spectra beyond tungsten slabs of thicknesses 4.4, 11, and 15.4 cm are given. For all the materials investigated the calculated and experimental results are in good agreement for energies above 1.5 MeV. To achieve better agreement between calculated and experimental data it is recommended that smaller energy groups be chosen and that additional averaging of group constants be performed over the actual spectrum, experimental or calculated, at each point of the medium. (auth)

49235 SLOWING DOWN OF NEUTRONS FROM A POINT SOURCE IN A SEMIINFINITE MEDIUM. Kozachok, I. A.; Kulik, V. V. This paper was summarized in At. Energ. (USSR); 25: 223–4(Sep 1968) as paper No. 225. (In Russian).

The problem of the slowing down of neutrons from a point isotropic monoenergetic source in a semiinfinite multicomponent medium with a plane boundary is discussed. It is assumed that the fundamental process by which neutrons interact with matter is elastic scattering and that all inelastic processes may be neglected. The problem is formulated by using the differential equation obtained in the P_2 approximation of the spherical harmonics method and is an approximation of the next order in comparison with age theory. The range of applicability of the new equation is appreciably broader than that for the equation obtained in the age approximation; in particular it is valid also for hydrogenous media. The problem is solved in cylindrical coordinates. The boundary is the plane z = 0 and the source is placed at the point $\rho = 0$, $z = z_0$. The boundary condition is that neutrons leaving the medium do not return. The solution shows that if the neutron source is placed close enough to the boundary, leakage will cause a decrease in neutron density throughout the whole moderating region and not just close to the boundary. This is a consequence of the fact that not only slow neutrons but an appreciable fraction of the fast neutrons escape from the medium and take no further part in the moderation process. (auth)

49236 MATRIX METHOD CALCULATION OF SPECTRAL AND ANGULAR CHARACTERISTICS OF GAMMA RADIATION INSIDE SLAB SHIELDS. Churin, S. A. This paper was summarized in At. Energ. (USSR); 25: 426–7(Nov 1968) as paper No. 239. (In Russian).

The spectral and angular distributions of gamma radiation inside a 20-cm-thick iron shield were found for three external sources having different spectral and angular distributions. By dividing a slab shield of arbitrary thickness into several elementary layers for each of which the reflection and transmission matrices are known, one can rather simply find the spectral and angular distributions of radiation inside a slab shield. The spectral and angular distributions of gamma radiation between two plane layers is determined from the expression $I = (E + R_2)(E - R_1R_2)^{-1}T_1I_0$, where the vector I_0 describes the radiation incident on the shield, R_1 and T_1 are respectively the reflection and transmission matrices of the first layer for the incident radiation, R_2 the reflection matrix for the second layer, and I the required radiation vector. The spectral and angular distributions of radiation inside a shield composed of n layers may be found by using this equation together with the following equations relating the R and T matrices for a two-layer shield: $T = T_2(E - R_1R_2)^{-1}T_1$; and $R = R_1 + T_1R_2(E - R_1R_2)^{-1}T_1$. Reflection and transmission matrices R_1 and T_1 of the 60th order (ten energies and six angular intervals) for an iron shield 2 cm thick were determined by the Monte Carlo method. Gamma fluxes computed by the above method are shown as a function of position in the shield for an 8-MeV isotropic source. (auth)

49237 MATRIX METHOD FOR CALCULATING GAMMA SHIELDS IN SLAB GEOMETRY. Churin, S. A.; Gokhshtein, L. E.; Sheiman, L. S. This paper was summarized in At. Energ. (USSR); 24: 257(Mar 1968) as paper No. 185. (In Russian).

A procedure using transmission and reflection matrices is presented for calculating, in slab geometry, the transmitted and backscattered radiation from sources having various spectral and angular characteristics. The spectral and angular distributions of the transmitted radiation $I_T(E, \theta)$ and that backscattered $I_R(E, \theta)$ for a two-layer slab shield are determined from the expressions $I_T = T_2(E - R_1R_2)^{-1}T_1I$; $I_R = [R_1 + T_1R_2(E - R_1R_2)^{-1}T_1]I$, where T_1 is the transmission matrix for the first layer, R_1 the reflection matrix for the first layer, and T_2 and R_2 the transmission and reflection matrices for the second layer. These equations may be used to find the spectral and angular distributions of transmitted and backscattered radiation for both homogeneous and heterogeneous slab shields having thicknesses which are integral multiples of the thicknesses of the original layers. Transmission and reflection matrices of the 42nd order for a layer of aluminum 2 cm thick and a layer of iron 1 cm thick were computed by the Monte Carlo method. Using these matrices the spectral and angular characteristics of backscattered radiation and that transmitted through a slab shield from gamma sources having energy spectra between 0.1 and 0.7 MeV and any angular distribution were calculated. The results are shown of the matrix calculation of the energy spectrum outside a 16 cm aluminum shield of the radiation from an isotropic source having the spectrum shown. The time to calculate the spectral and angular characteristics of radiation scattered by a slab shield a few mean free paths thick using this method is several orders of magnitude less than that required by the Monte Carlo method. It should be noted that the accuracy of the matrix calculation for a shield of arbitrary composition and thickness depends mainly on the spacing of the original matrices and the accuracy with which their terms were computed. (auth)

49238 SELF SHIELDING OF THERMAL NEUTRONS IN FINITE CYLINDERS AND IN BODIES OF OTHER SHAPES. Zharkov, V. A.; Zorina, T. P.; Fradkin, G. M. This paper was summarized in At. Energ. (USSR); 24: 371(Apr 1968) as paper No. 190. (In Russian).

In certain applied neutron physics problems, such as activation analysis, it is necessary to take account of the self-shielding effect of thermal neutrons in localized absorbers. The self-shielding effect is commonly characterized by the self-shielding factor G which may be written in the form $G = (\bar{\psi}/\Sigma_a X)$, where $\bar{\psi}$ is the average probability of absorption of thermal neutrons incident isotropically (the absorption probability depends somewhat on the angular distribution of the incident neutrons [1]), Σ_a the Maxwellian averaged macroscopic absorption cross section, $X = 4V/S$ the average path length of a neutron through the absorber for isotropic incidence, V the volume and S the surface area. The average macroscopic absorption cross section is $\Sigma_a = (\sqrt{\pi}/2)g(T)\Sigma_a$, where T is the temperature of the neutron gas in °K, Σ_a the macroscopic absorption cross section at energy kT, and g(T) a coefficient taking account of the deviation of the energy dependence of the cross section from the 1/v law; for the 1/v law g(T) = 1. Ordinarily, self-shielding is accompanied by a perturbation of the neutron flux incident on the absorber. In this case the total coefficient of decrease in absorption rate may be written as the product of the self-shielding factor and a coefficient characterizing the perturbation of the thermal neutron flux which in turn depends on the probability $\bar{\psi}$. Data are cited here on the probability $\bar{\psi}$ for finite cylinders of arbitrary parameters and pitch. Tabulated values of the function $\bar{\psi} = 1 - e^{-\frac{1}{4}\Sigma_a X}$, enable one to account approximately for self-shielding in convex bodies of arbitrary shapes. Calculations were performed for 1/v absorbers and for Ag, Cd, In, Sm, Eu, Gd, Hf, Au, and Hg absorbers. Values of the function $\bar{\psi}$ for 1/v absorbers are tabulated. (auth)

49239 INVESTIGATION OF THE ACCURACY OF THE P_2 APPROXIMATION IN DESCRIBING NEUTRON DIFFUSION IN A MEDIUM WITH A DUCT. Rumyantsev, G. Ya.; Dmitrieva, V. S. This paper was summarized in At. Energ. (USSR); 25: 515–16 (Dec 1968) as paper No. 247. (In Russian).

It is known that the presence of a duct in a medium leads to an appreciable increase in the diffusion neutron current both in the duct and in its vicinity. The ordinary diffusion approximation gives an infinite diffusion coefficient in the duct and therefore an infinite diffusion current if $\partial\Phi/\partial x \neq 0$, and no disturbance outside the duct. Qualitatively different results are obtained in the P_2 approximation. To investigate the accuracy and shortcomings of the P_2 approximation in solving such a problem, the problem of determining the effective longitudinal diffusion coefficient in an infinite, homogeneous, nonabsorbing medium with no neutron sources except at infinity, containing a cylindrical duct is considered. The medium is assumed to scatter isotropically. It is assumed that the integrated neutron flux $\Phi(r)$ is a linear function of z. The solution of this problem in the P_2 approximation is compared with the exact solution which also may be expressed in terms of definite integrals. The z axis coincides

with the axis of the duct, and for this direction $J_z = -D_{z,eff}(\partial\phi/\partial z)$, where $D_{z,eff} = (1/3\Sigma) + \delta D_z(r)$, and $\delta D_z(r)$ is the perturbation of the diffusion coefficient by the duct. The P_2 approximation gives for $\delta D_z(r)$ the simple formulas

$$\delta D(r) = \begin{cases} [\sqrt{5}r_0K_0(\sqrt{5}\Sigma r_0)]/[6K_1(\sqrt{5}\Sigma r_0)] \text{ in the duct;} \\ [\sqrt{5}r_0K_0(\sqrt{5}\Sigma r)]/[6K_1(\sqrt{5}\Sigma r_0)] \text{ in the surrounding medium.} \end{cases}$$

Here r_0 is the radius of the duct and K_n a Bessel function. Results calculated by using this last equation and the exact solutions are shown. (auth)

49240 METHOD FOR THE MEASUREMENT OF BUILDUP FACTORS IN THE GAMMA ENERGY REGION OF 0.5 TO 15 MeV. Futtermenger, W. (Technische Univ., Hanover). Atomkernenergie; 16: 57-63(1970). (In German).

The method described allows determination of dose buildup factors within the above energy range for point isotropic and plane collimated sources. In the arrangement a narrow collimated beam of bremsstrahlung produced in a betatron penetrates the shield model. The photon spectra of the scattered radiation and the unscattered radiation transmitted through the shield model are measured separately with a scintillation counter as detector. From the energy spectra, exposure doses and buildup factors for the spectra of the primary unscattered radiation were derived. These special buildup factors were measured for different maximum energies of bremsstrahlung of the betatron. A system of linear equations enables the calculation of buildup factors for monoenergetic radiation. Shield configurations up to 16 mean free paths can be investigated. Buildup factors measured for iron- and water shields agreed within the error limit of comparative theoretical results. The method was used to derive unknown buildup factors of a barite concrete and some iron/water multilayer shields. (auth)

49241 CALCULATION OF HEAT RELEASE IN CONCRETE SHIELDING. Kulakovskii, M. Ya.; Lavdanskaya, G. A.; Lavdanskii, P. A.; Savitskii, V. I.; Solov'ev, V. N. Sb. Tr., Mosk. Inzh.-Stroitel. Inst.; 56: 19-22(1968). (In Russian).

The heat release by captured gamma radiation must be carried out with a high degree of accuracy for fast reactor concrete shielding. A multigroup calculation of captured gamma quanta and the heat release caused by their absorption in the shielding material is presented along with a program for use on a computer. The maximum number of neutron groups is 18, and the maximum number of calculational points is 80. The maximum number of quantum groups is 5. The machine calculation time for a single variant is 5 minutes. The heat release from neutron capture by boron in the shielding material can be taken into account. (TTT)

49242 DIFFERENTIAL ALBEDO OF A THIN BEAM OF FAST NEUTRONS FOR A SEMIINFINITE SCATTERER CONSISTING OF IRON. Gudkova, L. Ya.; Zolotukhin, V. G.; Mashkovich, V. P.; Mis'kevich, A. I. This paper was summarized in At. Energ. (USSR); 25: 222-3(Sep 1968) as paper No. 224. (In Russian).

The Monte Carlo method was used to calculate the differential, spectral, numerical, and dosage albedos of a point unidirectional source (thin beam) of neutrons on a high-speed electronic computer; these albedos are specified in the form of rectangular spectra in the energy ranges ΔE_0 equal to 0.4 to 0.8, 0.8 to 1.4, 1.4 to 2.5, 2.5 to 4.0, 4.0 to 5.0, 5.0 to 6.5, 6.5 to 8.5, 8.5 to 10.5 MeV for various angles of incidence on a semiinfinite iron scatterer θ_0 ($0 \le \theta_0 \le 85°$) and the following reflection angles; the polar angle θ ($0 \le \theta \le 85°$) and the azimuthal angle φ ($0 \le \varphi \le 180°$). The program and method of the calculation are the same as they were in (At. Energ. (USSR), 22: 122(1967)). This work differs from previous computations in the following ways: (a) a detailed study is made of the dependence of the differential characteristics of the albedos on the azimuthal angle; (b) a semi-empirical formula is suggested for the differential characteristics of the albedos while taking into account the dependence on the azimuthal angle; (c) the energy distributions of the neutron sources are specified in the form of rectangular spectra in narrow energy intervals ΔE_0. The calculated values of the numerical and dosage differential albedos are tabulated. The results at the compared points are in agreement with previous calculations within the limits of the errors. Significant azimuthal variations of the differential albedos are noted at large angles θ_0 and θ. For example, for $\Delta E_0 = 4$ to 5 MeV and $\theta_0 = \theta = 85°$, the numerical albedo decreases almost by a factor of seven as φ varies from 0 to 180°. (auth)

49243 ANALYSIS OF TRANSMITTED GAMMA RAYS BY THE MULTIPLE SCATTERING METHOD. II. GAMMA RAYS TRANSMITTED THROUGH STRATIFIED SLABS. Harima, Yoshiko; Nishiwaki, Yasushi (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo); 7: 439-49(Sep 1970).

Dose buildup factors and number spectra of γ rays transmitted through stratified slabs were estimated by the multiple scattering method, taking scattering into consideration up to the fourth order and including backscattering. Further, the method proposed in the previous paper for estimating the contribution to the total dose buildup factor by γ rays of the fifth and higher orders of scattering was applied to the present case of stratified slabs made up of different materials. The calculations covered the range of source energy from 1 to 10 MeV, and various arrangements of strata made up of combinations of two of the three materials, water, iron, and lead, making up slabs of total thicknesses up to 6 mfp. Calculations were also performed for ^{60}Co γ rays normally incident on stratified slabs of water–lead–water. The results of the above calculations were found to be in good agreement with those of other calculations, such as by Monte Carlo method and by numerical integration of the photon transport equation. The present results were also found to agree well with the dose buildup factors calculated by our own empirical formula. Comparisons with experimental results too have proved good. (auth)

49244 EFFECTIVE ATOMIC NUMBERS FOR GAMMA-RAY INTERACTIONS IN ALLOYS. Rao, V. Seshagiri; Seetharamanath, M. N.; Murty, K. Narasimha; Parthasaradhi, K. (Andhra Univ., Waltair, India). Nucl. Sci. Eng.; 42: 109-11(Oct 1970).

The effective atomic numbers in materials composed of several elements can not be represented by a single number. For partial processes, the numbers have to be determined separately, since these partial interactions have different Z dependences. The expressions for estimating the effective atomic numbers for partial processes — incoherent scattering, photoelectric effect, and pair production — are given. These expressions are verified on the basis of the experimental data in a detailed manner and certain conclusions are drawn. (M.H.R.)

Solid-State Physics

Refer also to abstract 48029.

Radiation Effects

49245 (NYO-3464-25) LINEAR STARK EFFECT OF THE R' CENTER IN LiF. Davis, J. A.; Fitchen, D. B. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Aug 1970. Contract AT(30-1)-3464. 16p. Dep. CFSTI.

A resolved linear Stark splitting is observed for the R' zero-phonon line in absorption, in good agreement with the predictions for an $A \rightarrow E$ transition at a center of C_{2v} symmetry. (auth)

49246 (ORNL-TM-2986) THE DEVELOPMENT OF RADIATION-RESISTANT INSULATORS. Progress Report, July 1, 1967–July 1, 1969. Kelly, M. J.; Parkinson, W. W. (Oak Ridge National Lab., Tenn.). Aug 1970. 64p. Dep. CFSTI.

The apparent electrical conductivity of high-resistance plastics was examined from the standpoint of dielectric relaxation processes as well as steady-state conductivity. The observed, time-dependent conductivity of high-purity polystyrenes, commercial plastics of lower purity and of the copolymer in use for dosimeters can be accounted for on the basis of dielectric charging and low values of conductivity, both varying with the polar nature of the base polymer and the impurities. During irradiation the conductivity increases greatly depending on the dose rate and decays after irradiation with a time dependence related to the composition of the specimen. To be suitable for dosimeter use, the radiation-induced conductivity must decay rapidly, to values below 10^{-19} mhos/cm in 10^4 seconds. The currently used material, a copolymer of styrene and α-methyl styrene (Cerex 250B), was found to have unusually rapid decay of conductivity following irradiation. By polymer fractionation and by varying the synthesis ingredients, the chemical species active in reducing conductivity was identified as sulfate chain ends arising from persulfate initiator in the polymerization recipe. Styrene homopolymers were synthesized with sulfate end groups and shown to have as low conductivity as the copolymer. Polymers with sulfate end groups and (NH_4) cations showed low but erratic conductivity and polystyrenes having end groups of moderate polarity have lower dielectric charging prior to irradiation and some reduction in postirradiation conductivity. Methods are proposed for development work to exploit these possibilities for improving plastic insulators. (auth)

49247 RADIATION-IONIZATION ENERGY AND FANO FACTOR IN SEMICONDUCTORS. I. Antoncik, E. (Univ. of Aarhus, Denmark); di Cola, G.; Farese, L. Radiat. Eff.; 5: 1-13(Aug 1970).

A system of equations describing the production of electron–hole pairs in semiconductors by energetic electrons and holes is given for the low-energy region. It is assumed that electron–phonon interaction and interband Auger transitions constitute the dominant slowing-down mechanisms. Quantitative estimates are obtained for the influence of parameters characterizing both the band structure and the interactions under consideration on the mean number $\bar{g}$ of electrons and holes created. Also, the second-order moment $\bar{g}^2$ and the Fano factor F are calculated. Furthermore, the problem of energy transfer to the crystal lattice is discussed in detail. The radiation–ionization energy ϵ and the corresponding phonon-loss part ϵ_{ph} are estimated for several typical band-structure models. (auth)

49248 AGGLOMERATION OF POINT DEFECTS IN IRRADIATED METALS DESCRIBED BY CHEMICAL-KINETIC EQUATIONS. Bourret, A. (CEN, Grenoble, France). Radiat. Eff.; 5: 27-36(Aug 1970). (In French).

Chemical reaction rate theory was developed to account for several agglomeration processes in irradiated metals. In particular, it has been found that the exact number of point defects forming the nucleus is of no importance and is not detectable experimentally. In contrast, the stability of the intermediate form leading to the stable nucleus plays an important role. Moreover, it is emphasized that special conditions are needed to be sure that chemical reaction rate theory is applicable. In particular, the number of Frenkel pairs N produced per knock-on atom is an important parameter especially at low temperature. The probability of obtaining inhomogeneous nucleation increases with N. (auth)

49249 MEASUREMENT OF THE MEAN RANGE OF FISSION FRAGMENTS WITH MICA AS DETECTOR: INFLUENCE OF CRYSTAL STRUCTURE. Mory, J.; de Guillebon, D.; Delsarte, G. (CEN, Fontenay-aux-Roses, France). Radiat. Eff.; 5: 37-40(Aug 1970). (In French).

Mica is used as a detector to measure the mean range of uranium-235 fission fragments in different metals. This evaluation is made in order to obtain a calibration table to analyze afterwards the concentration of fissile elements in some alloys. The results, expressed in mg cm^{-2}, are the following, for cold-worked samples: Al: 2.84; Ti: 3.82; Fe: 4.22; Ni: 4.40; Cu: 5.08; Zr; 4.70; Nb: 4.78; Mo: 5.18; Pd: 5.32; Ag: 5.40; Ta: 6.32; W: 7.35; Au: 8.50. With a few exceptions these mean ranges are linearly proportional to the square root α the atomic number of the element in study. Influence of channeling on the range evaluation is also studied. The method is to anneal the cold-worked samples at different temperatures, resulting in different crystallographic textures. It is found that the measured ranges depend significantly on the texture of the sample owing to the channeling of fission fragments in the samples. (auth)

49250 CLUSTER FORMATION DURING IRRADIATION WITH 2-MeV ELECTRONS. Salamon, K. (Univ., Frankfurt am Main); Schuele, W. Radiat. Eff.; 5: 49-50(Aug 1970).

The formation of point defect clusters, i.e., sinks for point defects in α-copper–zinc alloys during irradiation with 2-MeV electrons was studied by means of a decrease of the diffusion rate during prolonged irradiation. It was found that the free migrating interstitials are rate determining for the diffusion process during irradiation. Their activation energy gave 0.7 eV. With increasing electron dose, the diffusion rate decreases due to the formation of sinks which cause a reduction of the concentration of interstitials with respect to the concentration in virgin specimens. (auth)

49251 DEFECT PRODUCTION RATES IN ELECTRON-IRRADIATED ALUMINUM. Wurm, J.; Dworschak, F.; Schuster, H.; Wollenberger, H. (Van de Graaff-Labor, Aachen. Technische Hochschule, Aachen). Radiat. Eff.; 5: 117-21(Aug 1970).

The cross section for atomic displacement has been determined at 7.5°K by means of electrical resistivity measurements in electron-irradiated aluminium up to transferred energies of 1100 eV. These data and those from the literature have been evaluated with respect to the displacement function (DF). Below 200 eV, the DF could be derived from the data with sufficient accuracy by solving the integral equation which describes the displacement cross section. Above 200 eV, a family of nonlinear and linear DF's has been found which fits the data within the experimental error. From the linear DF's, one obtains an average threshold energy of 62 ± 6 eV according to Kinchin and Pease. (auth)

49252 COMMENTS ON DAMAGE PRODUCTION IN CADMIUM AT LOW TEMPERATURES. Coltman, R. R. Jr.; Klabunde, C. E.; Redman, J. K.; Southern, A. L. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 5: 139-41(Aug 1970).

For electron irradiation of Cd at 4.6°K, Maury, Lucasson, and Lucasson (MLL) (Radiat. Eff. 1: 241 (1969)) explained the rapid, early decrease of the damage production rate to a constant value at 1.4×10^{-10} Ω cm damage resitivity, as being due to the loss of close pairs through subthreshold events. They extended this interpretation to the author's results on thermal neutron irradiation of Cd monocrystals at 3.6°K (International Conference on Vacancies and Interstitials in Metals (Jülich, 1968)). Further data, which includes isochronal anneals, show that the maximum amount of resistivity which recovers in the 5.2°K peak is 2.2×10^{-4} Ω cm. The variation of the anisotropy of the 5.2°K defects from 1.22 is less than 4%, much smaller than the 30% proposed by MLL. Accordingly, it is still believed that the low dose variations in thermal neutron damage rate behavior are almost entirely due to variations in the electrical size effect, and that the influence of other radiations from the reactor core or of subthreshold events are negligible. A reply by MLL is included. (D.L.C.)

49253 ION IMPLANTATION IN SEMICONDUCTORS: SILICON AND GERMANIUM. Mayer, James W.; Eriksson, Lennart; Davies, John A. New York; Academic Press Inc. (1970). 290p. $13.50.

This monograph reviews recent developments in ion implantation in Si and Ge, with emphasis on basic aspects. The six chapters are titled: general features, ranges and range distribution of implanted atoms, lattice disorder and radiation damage, lattice location of implanted atoms, Hall-effect and sheet-resistivity measurements in Si, and device considerations and applications. An appendix on channeling behavior of low-Z, MeV particles in diamond-type lattices is included. (D.L.C.)

49254 ANGULAR CORRELATION OF POSITRON ANNIHILATION RADIATION IN DAMAGED NICKEL AND IRON. Huang, Hsien Chen. Kalamazoo, Mich.; Western Michigan Univ. (1969). 64p.

Thesis.

The shape of the angular correlation curves produced by two-quantum positron annihilation radiation in 2%, 4%, 8%, and 16% plastically deformed nickel and in electron-irradiated nickel and iron has been observed and compared with that obtained from the same specimens after annealing at 100°C, 250°C, and 400°C. The changes in the angular correlation for plastically deformed or radiation damaged specimens consist of an increase of annihilations at small angles and a corresponding decrease at large angles. Annealing the specimens at temperatures no higher than 400°C results in angular correlation curves similar to those for the undamaged metals. Apparently vacancies are the major cause of the altered shape of the angular correlation curve observed for a damaged specimen. (Masters Abstr.)

49255 THERMOLUMINESCENCE OF BIOLOGICAL MATERIALS. Jasinska, M.; Niewiadomski, T. (Inst. of Nuclear Physics, Krakow). Nature (London); 227: 1159-60(12 Sep 1970).

Some studies are reported on the bones of dinosaurs, and other organic fossil and contemporary samples. A difficulty arose from changes in the sample due to the combustion of organic compounds during the heating process for obtaining a flow curve, and it was necessary to remove these compounds before attempting measurements. It was also found desirable to make the measurements without any large temperature increase in order to preserve the natural radiothermoluminescence. During long periods underground the fossil bones absorbed a high radiation dose from the radionuclides inside deposites and from cosmic radiation, and at the same time natural processes removed organic compounds from the fossil bones. Other samples investigated were incinerated at 400°C just before thermoluminescence measurement since no better preparation method had been developed, and they were examined only for the artificially induced radiothermoluminescence. The experimental details are briefly described; irradiations were made with ^{60}Co gamma radiation. Tribothermoluminescence was induced by vigorous rubbing of the sample in a mortar, and some samples showed this phenomenon equivalent to a dose of many thousand rads. In some cases the radiothermoluminescence was visible with the naked eye. Some of the glow curves are reproduced. It is possible that the technique might be used for dating. (UK)

49256 ELECTRON PARAMAGNETIC RESONANCE IN GAMMA-RAY-IRRADIATED NIOBIUM-DOPED CALCIUM MOLYBDATE. Breslow, Richard A.; Owens, Frank; Gilliam, O. R. (Univ. of Connecticut, Storrs). J. Chem. Phys.; 53: 2143-7 (15 Sep 1970).

Calcium molybdate ($CaMoO_4$) doped with niobium impurity ions was studied by electron paramagnetic resonance (EPR). Single crystals were irradiated with ^{60}Co gamma rays at 77°K, causing three paramagnetic species. One of these is associated with the

niobium impurity ion substitutional for molybdenum; the major part of its EPR spectrum showed an $S = \frac{1}{2}$ defect with a 10-line hyperfine structure for each of four equally probable defect sites. Normally forbidden $\Delta M_I = \pm 1$ transitions were also observed. The spectra were fit to a rhombic spin Hamiltonian with parameters: $g_{xx} = 2.006 \pm 0.002$, $g_{yy} = 2.011 \pm 0.002$, $g_{zz} = 2.053 \pm 0.002$, $|A_{xx}| = 23 \pm 2$ G, $|A_{yy}| = 30 \pm 2$ G, and $|A_{zz}| = 30 \pm 2$ G where zz lies approximately along a normal Mo–O bond direction in the lattice. A partially resolved six-line ligand hyperfine structure appeared on the major resonances with the intensity expected for overlapping ^{95}Mo and ^{97}Mo hyperfine interactions. The model proposed for this defect is a hole shared between adjacent niobate and molybdate complexes with a higher probability density on the niobate. (auth)

Physical Properties

Refer also to abstracts 48830, 48833, and 49683.

49257 (ORO–2413-25) PROGRESS REPORT [ON ATOMIC MOBILITY IN SOLIDS], JUNE 1, 1969–JANUARY 31, 1970. (Wake Forest Coll., Winston-Salem, N. C.). Contract AT(40-1)-2413. 12p. Dep. CFSTI.

The atomic mobility in ionic crystals and silver solid solutions was studied by using optical absorption, dielectric loss, ionic thermocurrent, internal friction, and resistivity measurements. A Meechan–Brinkman analysis was performed on the deformation band in CaO. Isochronal decay curves of the deformation band in SrO were obtained. Attempts to obtain a deformation band for CaF_2 were unsuccessful. From preliminary internal friction studies on MgO at 25 to 400°C the logarithmic decrement was found to have double-valued behavior as a function of strain amplitude. The kinetic recovery of defects in AgAu alloys at strains less than 2% and greater than 10% is discussed. (G.M.C.)

49258 (UUIP–684) INTERNAL FIELDS AND RELAXATION EFFECTS FOR Dy IN FERROMAGNETIC $TbAl_2$ STUDIED BY PAC. Waeppling, R.; Karlsson, E.; Carlsson, G.; Bajaj, M. M. (Uppsala Univ. (Sweden). Inst. of Physics). Feb 1970. 24p. Dep. CFSTI (U. S. Sales Only).

The magnetic hyperfine field for Dy in $TbAl_2$ was measured in the temperature range 1.5 to 130°K using the PAC technique where PAC stands for Perturbed Angular Correlation. Thermal equilibrium after the radioactive decay was not reached during the observation time ($\tau_N = 3.1 \times 10^{-12}$ sec) and the effective field was therefore reduced. The role of electronic spin relaxation in PAC is discussed in detail. The relaxation time was measured between 4°K and room temperature and was found to be of the order of 10^{-12} sec. The temperature variation of the hyperfine field is consistent with the trend expected from a molecular field model. (auth) (Sweden)

49259 (UUIP–695) HYPERFINE INTERACTIONS IN Ho(Er)Al_2. Waeppling, R.; Karlsson, E.; Carlsson, G.; Bajaj, M. M. (Uppsala Univ. (Sweden). Inst. of Physics). Mar 1970. 23p. Dep. CFSTI (U. S. Sales Only).

The Perturbed Angular Correlation technique (PAC) was used to study the effect of the cubic crystal field on the electronic levels of Er^{3+} ions in $HoAl_2$ and it was found that the crystal field splitting is very small. The electronic relaxation time was determined at 295, 80, and 4°K and the results support a spin–spin relaxation mechanism. The hyperfine field acting on an ^{166}Er nucleus at 4°K was obtained as 3.5 ± 1.3 MG. The nuclear g-factor of the 6^+ state at 545 keV in ^{166}Er was found to be $+0.16 \pm 0.04$. The order of magnitude of the g-factor of the 7^+ state at 1375 keV was evaluated to 0.2. (auth) (Sweden)

49260 (UUIP–702) ELECTRON INTERACTION IN TRANSITION METAL X-RAY EMISSION SPECTRA. Ekstig, Boerje; Kaelinc, Elisabeth; Noreland, Erik; Manne, Rolf (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1970. 28p. Dep. CFSTI (U. S. Sales Only).

The $K\beta_1\beta'$ structure was investigated experimentally for all pure elements of the first transition series and for some of their compounds. Analogous structures were found for L emission spectra of some second transition series elements as well as of gadolinium. Relative transition energies and probabilities are calculated in a frozen-orbital approximation for the transition from a normal K state to singly ionized states of the configuration $3p^53d^n4s^1$ for the elements Sc through Ni. The results support the interpretation that the $K\beta_1\beta'$ structure is due to the electron interaction between partially filled 3p and 3d subshells. The electron interaction mechanism also explains the effects in the heavier elements investigated. (auth) (Sweden)

49261 MAGNETIC PROPERTIES OF Tb–Ho SINGLE-CRYSTAL ALLOYS. II. NEUTRON-DIFFRACTION STUDIES. Spedding, F. H.; Ito, Y.; Jordan, R. G. (Iowa State Univ., Ames). J. Chem. Phys.; 53: 1455-65(15 Aug 1970).

A neutron diffraction study of single-crystal Tb–Ho alloys is reported. Three single-crystal samples, containing 10%, 50%, and 90% Ho, were studied in detail from 5–298°K. It is found that all three alloys have similar ordered phases with uniform magnetic structures. Between the Néel temperature and Curie temperature, each alloy exhibits a spiral magnetic structure with the magnetic moments confined to the basal plane of the hcp structure. The temperature dependence of the interplanar turn angle changes gradually from that similar to pure Tb to that of pure Ho as the Ho concentration increases. Below the Curie temperature, all the alloys exhibit a collinearly ferromagnetic structure with the magnetic moments parallel to or closely parallel to the basal plane. The transition temperatures agree well with the corresponding values determined from magnetization measurements. The observed magnetic form factors also show a gradual change in shape as the Ho concentration increases from the shape similar to pure Tb to that of pure Ho. They show little change with temperature (within the accuracy of the present experiment) in the temperature range of the magnetically ordered states for each alloy. Similarities found between the magnetic properties of the 50% alloy and pure Dy are discussed. (auth)

49262 CALCULATION OF NEUTRON MAGNETIC FORM FACTORS FOR RARE-EARTH IONS. Lander, G. H. (Argonne National Lab., Ill.); Brun, T. O. J. Chem. Phys.; 53: 1387-91 (15 Aug 1970).

Certain coefficients that arise in considering the magnetic scattering of neutrons from rare-earth tripositive ions have been calculated, by using the tensor approach of Johnston, Rimmer, and Lovesey. Together with the $\langle j_l \rangle$ integrals derived from the radial wavefunctions, tabulated, for example, by Blume et al., these coefficients allow the neutron magnetic form factors for the rare-earth ions to be derived. An additional advantage of the tensor approach is illustrated by a discussion of the asymmetry of the magnetization distribution, arising from the coupling of orbital and spin moments. (auth)

49263 SURFACE WORK FUNCTION OF GADOLINIUM. Ramey, R. L.; Katzberg, S. J. (Univ. of Virginia, Charlottesville). J. Chem. Phys.; 53: 1347-8(15 Aug 1970).

A contact potential difference measurement of gadolinium against platinum yielded a work function of 2.90 ± 0.06 eV. (auth)

49264 THEORY OF DOUBLE ELECTRON-NUCLEAR RESONANCE IN THE PRESENCE OF AN ELECTRIC FIELD. Deigen, M. F.; Roitsin, A. B. (Inst. of Semiconductors, Kciv). Zh. Eksp. Teor. Fiz.; 59: 209-17(Jul 1970). (In Russian).

A calculation method is developed and general expressions are obtained for the paramagnetic center (PC) spin-Hamiltonian constants in the presence of an external electric field. A comparison of the theoretical and experimental results yields the sign and magnitude of the ion shifts near the PC, i.e., the local deformation. A method is proposed for determining the wave functions of the PC excited states on basis of the data pertaining to the shift of the ENDOR line under the action of an external electric field. The method is illustrated in the case of F centers in alkali-halide crystals. The ion shifts and values of the square of the modulus of the excited state wave function at the sites of the ions for the I, II, and IV coordination spheres in KCl and KBr crystals are determined. (auth)

49265 EFFECTS OF THE NEEL TRANSITION ON THE THERMAL AND ELECTRICAL RESISTIVITIES OF Cr AND Cr-Mo ALLOYS. Meaden, G. T.; Rao, K. V.; Tse, K. T. (Dalhousie Univ., Halifax, Nova Scotia). Phys. Rev. Lett.; 25: 359-62 (10 Aug 1970).

Thermal conductivity enhancements due to magnetic phase transitions have been observed for chromium, chromium–molybdenum alloys, and several rare-earth metals. The phenomenon can thus no longer be considered an uncommon one in metallic systems. In chromium, it appears to be sensitive to the microscopic state of particular samples. (auth)

49266 EFFECTS OF PRESSURE ON THE GALVANOMAGNETIC EFFECT AND THE CRITICAL FIELD IN A DYSPROSIUM SINGLE CRYSTAL. Nikitin, S. A.; Solntseva, L. I. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 59: 351-5(Aug 1970). (In Russian).

The influence of pressure on the galvanomagnetic effect in dysprosium single crystals is measured at temperatures between 85 and 177°K. A strong dependence of the pressure-induced shift of

the critical field on temperature is observed. A thermodynamic analysis of the experimental data for dysprosium shows that the increase of the critical field with pressure at 110 to 140°K can be explained by the growth of exchange interaction. The correlations between dH_c/dp and dH_c/dT and also between the magnetostriction and dH_c/dp found in the present investigation indicate that the decrease of H_c due to cooling below 160° K, which results in a transition to the ferromagnetic state, occurs in dysprosium as a result of anomalous growth of the lattice constant c below the paramagnetism–helicoidal antiferromagnetism transition temperature. (auth)

49267 CRYSTAL FIELDS IN RARE-EARTH METALLIC COMPOUNDS. Turberfield, K. C. (Brookhaven National Lab., Upton, N. Y.); Passell, L.; Birgeneau, R. J.; Bucher, E. Phys. Rev. Lett.; 25: 752-5(14 Sep 1970).

Neutron crystal-field spectroscopy has been carried out in a series of praseodymium monochalcogenides and monopnictides; the results illustrate the power of inelastic neutron scattering techniques in such problems. It is found that all of the crystal-field levels in all compounds studied can be quantitatively accounted for by use of a simple point-charge model. (auth)

49268 ANALYSIS OF CRITICAL NEUTRON-SCATTERING DATA FROM IRON AND DYNAMICAL SCALING THEORY. Als-Nielsen, J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 25: 730-4(14 Sep 1970).

Experimental three-axis spectrometer data of critical neutron-scattering data from Fe are reanalyzed and compared with the recent theoretical prediction by Résibois and Piette. The reason why the spin-diffusion parameter did not obey the prediction of dynamical scaling theory is indicated. Double-axis spectrometer data have previously been interpreted in terms of a non-Lorentzian susceptibility $\chi(q)$. It is shown that with proper corrections for the inelasticity of the scattering, the data are consistent with a Lorentzian form of $\chi(q)$. (auth)

49269 LOW-ENERGY ELECTRON DIFFRACTION STUDY OF TUNGSTEN (100) SURFACE. Wei, P. S. P. (Bell Telephone Labs., Murray Hill, N. J. Boeing Scientific Research Labs., Seattle). J. Chem. Phys.; 53: 2939-45(1 Oct 1970).

The diffraction of electrons by a tungsten (100) surface was studied in a display-type LEED apparatus. The sample surface was cleaned by repeatedly heating to 2300°K in high vacuum. Instrumental factors and the effect of adsorption of ambient gases on intensities were checked. The 00 beam intensity profile was measured in the energy range 100 to 300 eV for sequences of primary-beam orientations. Special effects associated with the simultaneous occurrence of different Bragg conditions were found. A tabulation of energies and orientations at which simultaneous Bragg conditions occur is presented. (auth)

49270 MAGNETIC AND CRYSTALLOGRAPHIC CHARACTERISTICS OF THE TERNARY INTERMETALLIC COMPOUNDS CONTAINING LANTHANIDES AND IRON OR COBALT. Shidlowsky, I.; Wallace, W. E. (Univ. of Pittsburgh). J. Solid State Chem.; 2: 193-8(Aug 1970).

The ternary alloy systems $GdCo_{5-x}Al_x$, $GdCo_{5-x}Cu_x$ and $La_{1-x}Zr_xFe_2$ (with La = Gd, Dy, and Ho) were studied to ascertain whether the antiferromagnetic coupling between the sublattices in the parent compound, $GdCo_5$ or $LaFe_2$, can be reversed by forming the ternary intermetallics. It was expected that replacement of Co with Al or Cu and of La with Zr would increase the electron concentration and in consequence the sign of the intrasublattice magnetic interactions might be reversed. Results showed the Gd–Co coupling remains antiferromagnetic up to the phase boundary, x = 1.75 and 4.20 for the Al- and Cu-containing ternaries, respectively. The saturation magnetization of ternaries indicates a steadily declining Co moment as Cu or Al is introduced. From the observed moments it is clear that cobalt absorbs electrons into its d-shell and at such a rate that the electron concentration is not increased by introducing Cu or Al. Similar results were obtained for the $LaFe_2$-based ternaries and again it appears that the d-transition element, Fe, absorbs electrons at a rate to preserve a constant electron concentration. In both the Haucke and Laves phase systems it appears that Brillouin Zone filling is an important consideration. In both $GdCo_5$ and the $LaFe_2$ compounds the Fermi sphere seems to be in contact with a zone boundary so that increasing the electron concentration is energetically difficult and additional electrons are accommodated instead in essentially localized d-states associated with Fe or Co. This analysis provides a basis for understanding the phase boundaries in the $GdCo_5$-based systems and the nonexistence of $GdCu_5$, $GdAl_4$, and $ZrNi_2$. The lattice parameters vary linearly with composition for all systems studied. $ZrFe_2$ is miscible in all proportions with $DyFe_2$ and $HoFe_2$, the ternaries all having the C 15 structure. $ZrFe_2$ and $GdFe_2$ have limited miscibility. The C 15 structure exists in $Gd_{1-x}Zr_xFe_2$ for x = 0 and for x = 0.8 to 1.0; the system consists of two phases for $0 \leq x \leq 0.8$. (auth)

49271 ELECTRON SPIN RESONANCE INVESTIGATION OF THE CONDUCTING DIHYDRIDES OF GADOLINIUM AND GADOLINIUM–YTTRIUM ALLOYS. Uhrich, David L.; Schumacher, David P. (Univ. of Pittsburgh). J. Chem. Phys.; 53: 2284-90(15 Sep 1970).

Electron spin resonance linewidths and g shifts were obtained in the temperature range 100 to 300°K for the gadolinium f electrons in the systems MH_x ($1.90 < x < 2.46$; M = Gd, $Gd_{0.71}Y_{0.29}$, or $Gd_{0.50}Y_{0.50}$). The systems behave differently depending on whether $x > x_c$ or $x < x_c$; x_c = 2.12, 2.07, 1.91 for M = Gd, $Gd_{0.71}Y_{0.29}$, and $Gd_{0.50}Y_{0.50}$, respectively. For $x > x_c$, the g shifts (relative to g for Gd in insulators) were ≈ +0.01, independent of x and of temperature. These shifts are interpreted as the result of the exchange interaction $-JS \cdot s$ between the gadolinium f electrons and the s conduction electrons, indicating that hydrogen enters the lattice as H^-. The g values are slightly temperature-dependent for $x < x_c$. The linewidth is proportional to the temperature, characteristic of the Korringa formula, above $x = x_c$. Below $x = x_c$ the linewidth becomes temperature-independent and increases with decreasing hydrogen content. This temperature-independent broadening is linked with vacant tetrahedral interstices, normally occupied by hydrogens in the face-centered cubic metal lattice. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 48350 and 48351.

49272 (CONF-690201–(Abstr.)) 10th EXPERIMENTAL NMR CONFERENCE, PITTSBURGH, PA., FEBRUARY 27–MARCH 1, 1969. (Mellon Inst., Pittsburgh, Pa.). 98p. Dep.

About 50 abstracts of presentations at the conference are included. Some of the topics are: superconducting solenoids, high-resolution NMR, dynamic polarization, spectral analysis, spectrometers and techniques, chemical shift anisotropies, ^{13}C NMR, Overhauser effects, double resonance, and liquids. (D.L.C.)

49273 (RLO–2225-T-12-1) ROLE OF THE MOESSBAUER EFFECT IN SOLID STATE STUDIES AT HIGH PRESSURE. Ingalls, Robert L. (Washington Univ., Seattle). [1970]. Contract AT(45-1)-2225. 33p. Dep. CFSTI.

This lecture concentrates on general and fundamental relationships between the nucleus and surrounding electrons as well as between the Moessbauer atom and its neighbors. The atomic parts of the various electric and magnetic hyperfine interactions are discussed, as well as lattice dynamics and relaxation. Examples, including high-pressure experiments, are given with emphasis on ^{57}Fe. (D.L.C.)

49274 INFLUENCE OF THE ANISOTROPIC SLOWING-DOWN OF ^{24}Mg RECOILS IN Na AND NaCl SINGLE CRYSTALS. Kalus, J.; Menzel, H. G.; Ziesemer, K. (Technische Hochschule, Munich). Z. Phys.; 238: 43-8(1970). (In German).

The relative nuclear resonance fluorescence (NRF) yield of 1.37-MeV quantas, emitted from ^{24}Mg recoils, was determined in a scattering experiment. In single crystals of Na and NaCl, which were doped with ^{24}Mg and irradiated to produce ^{24}Na, a dependence of the NRF yield on the direction of the emitted gamma quantas relative to the orientation of the crystals, was observed. The effect can be explained by taking into account the anisotropic deceleration of the ^{24}Mg recoils in the single crystals. The deceleration was calculated by using Born–Mayer potentials. Results of the calculations of the anisotropic NRF yields are presented and discussed. (auth)

49275 CONTRIBUTION TO THE STUDY OF DYNAMIC POLARIZATION BY SOLID EFFECT. Baldacchini, G.; Montelatici, V. (CNEN, Frascati, Italy). Nuovo Cim.; 68B: 253-81 (11 Aug 1970).

The theory of solid effect is developed from a thermodynamical and statistical approach by introducing a chemical potential for each group of the spins of the system according to their states. The entropy production rate is written as a function of chemical potentials and transition probabilities. The mechanisms of the relaxation processes are specialized, and the energy balance among Zeeman and phonon energies and the energy flux to the heat bath is considered. In this way two coupled equations are obtained for the polarizations of ions and protons, which are linearized by using deduced relations, at stationary state, among the chemical potentials and the ion and proton relaxation times ratio, in the limit case when the electronic Boltzmann factor is transferred to protons. The proton relaxation time and the dy-

namic polarization at 6370 G, in the helium-temperature range, are measured in LaMN crystals doped with 1% and 3.5% of neodymium ions. The experimental relaxation times are in good agreement with the theoretical values. Discrepancies are found concerning the dependance of relaxation times on the concentration of impurities. The experimental dynamic polarization values, whose maximum is about 20% for 1% doping, show a marked effect of direct cooling by the electron system, an effect already reported at lower magnetic fields by other authors. (auth)

49276 OBSERVATION OF ADIABATIC NUCLEAR MAGNETIZATION IN NUCLEAR ORIENTATION EXPERIMENTS. Chaplin, D. H.; Don, C. G.; Wilson, G. V. H. (Monash Univ., Clayton, Australia). Phys. Lett., A; 32: 137-8(9 Jun 1970).

Measurements of the anisotropy of γ radiation from ^{60}Co in iron show adiabatic bulk nuclear magnetization when the sample is magnetized at 0.05°K to 0.010°K for ^{54}Mn in copper at 0.025°K in 0.5 kG to 3 kG, $T_1 \leq 0.5$ sec. (auth)

Theory

49277 GREEN FUNCTION APPROACH TO THE PARAMAGNETIC PHASE OF A HEISENBERG FERROMAGNET. Knapp, R. H. Jr.; Ter Haar, D. (Oxford Univ.). pp 341-8 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

A higher-order decoupling similar to the first-order Bogolyubov-Tyablikov decoupling is used to find various correlation functions in the paramagnetic region of a Heisenberg ferromagnet. Expressions are given for the susceptibility and the nearest-neighbor correlation and autocorrelation at the critical point as well as at high temperatures. (auth)

Theoretical Physics

Refer also to abstract 49589.

49278 (SC-R-70-4277) SCATTERING BY IMPERFECTLY CONDUCTING SPHERES. King, Ronold W. P. (Harvard Univ., Cambridge, Mass. Gordon McKay Lab. of Applied Science); Harrison, Charles W. Jr. (Sandia Labs., Albuquerque, N. Mex.). Jul 1970. Contract F19(628)-68-C-0030. 42p. Dep. CFSTI.

The theory of scattering by an imperfectly conducting, dielectric or plasma sphere is reviewed briefly. Numerical values of the backscattering and forward scattering cross sections of spheres are given over wide ranges of the radius, the conductivity, and the permittivity including both positive and negative values. The angle of the electric field in the forward and backward directions is also represented. (auth)

49279 QUANTENTHEORIE. (Quantum Theory). Franz, W. Berlin; Springer-Verlag (1970). 312p. $24.20.

An introductory textbook on quantum theory, this book covers the following topics: heuristic introduction to quantum theory, principles of quantum theory, quantum theory of atomic systems, scattering and decay, and field quantization. (M.C.G.)

49280 PHENOMENOLOGICAL MODEL OF COOPERATIVITY. Frankel, N. E. (Univ. of Melbourne). Progr. Theor. Phys. (Kyoto); 43: 1148-69(May 1970).

A new nonclassical phenomenological model of cooperative phenomena in three dimensions is presented. An equation for the long range order parameter which gives excellent agreement with known results for physical systems is developed. A physical model of the cooperative phenomenon which motivated this equation is also presented. The model preserves the essence of the classical theory while incorporating the correct critical point behavior as exhibited in nature. The model is shown to be in accord with the scaling laws describing the critical region in 3-d. It provides additional insight into the fundamental problems involved in creating a theory of phase transitions. (auth)

49281 REDUCED MATRIX ELEMENTS OF TENSOR OPERATORS. Briggs, John S. (Argonne National Lab., Ill.). J. Math. Phys. (N. Y.); 11: 1198-1204(Apr 1970).

Reduced matrix elements of a tensorial product of n tensor operators in the basis of N-particle angular-momentum eigenstates are expanded into a sum of products of n 1-particle reduced matrix elements and a single (N + n)-particle recoupling coefficient. Application of the formula is illustrated by specific examples. The method leaves the coupling schemes of N-particle states undisturbed, which allows summation over intermediate states in a product of matrix elements to be made for any number of factors. A formula is given for the sum of products of two matrix elements and the extension to a greater number of matrix elements is illustrated by an example which is reduced to a form suitable for numerical evaluation. Such summations over products of matrix elements occur in the perturbation theory of configuration interaction and have hitherto been discussed in terms of effective operators. The connection of the method used here with the effective-operator approach is demonstrated. (auth)

49282 PROBLEMY TEORETICHESKOI FIZIKI. (Problems of Theoretical Physics). Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). 431p. (In Russian and English).

Thirty-five essays dedicated to N. N. Bogolyubov on the Universe and particles, general problems of quantum field theory, theory of elementary particles, and quantum many-body problems are presented. Separate abstracts were prepared for 32 of the papers. (W.D.M.)

For abstracts of individual papers see: 48979, 48984, 49085, 49277, 49283–49288, 49357, 49412, 49413, 49438–49441, 49498, 49552, 49563, 49572–49577, 49599, 49613–49616, and 49950.

49283 REMARKS ON A CONJECTURE OF ROBINSON AND RUELLE CONCERNING THE QUANTUM MECHANICAL ENTROPY. Bauman, F.; Jost, R. (Eidgenoessische Technische Hochschule, Zurich). pp 285-93 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

The conjecture, which generalized a well-known property of the classical entropy to quantum mechanics, is a special case of a conjecture of Robinson and Ruelle. It is reduced to a convexity statement. The conjecture is proven for positive operators in two dimensions. (auth)

49284 REMARKS ON THE BOGOLYUBOV MODEL FOR BOSONS AND SIMILAR MODELS. Hugenholtz, N. M. (State Univ., Groningen, Netherlands). pp 311-17 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

The Bogolyubov model for interacting bosons and similar models are investigated in the framework of the algebraic approach to statistical mechanics. Special attention is given to the old problem of the connection between the non-gauge-invariant ground state as found by Bogolyubov and the gauge-invariant state which one obtains by taking the thermodynamical limit of the ground state of a finite system. (auth)

49285 ROTATIONAL ENERGY OF INTERACTING PARTICLE SYSTEMS. Davydov, A. S.; Filippov, G. F. (Inst. of Theoretical Physics, Kiev). pp 318-28 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

The problem of the determination of the energy of a system of interacting particles is investigated. It is shown that the separation of the rotational energy from the total energy of a system is a function of the symmetry of the average distribution of particles in its volume. For the case of four particles, a relation between the moments of inertia defining the energy of the rotational states and the distribution of particles over the volume is established. In particular, it is shown that if the equilibrium configuration of particles corresponds to a regular tetrahedron, then the rotational energy operator includes the moments of inertia corresponding to the difference of the main axes of an instantaneous ellipsoid and the sphere radius to which the ellipsoid for a regular tetrahedron is degenerated. A relationship of the obtained results with the Hamiltonian operator of the unified nuclear model is discussed. (auth)

49286 KINETIC THEORY AND SUBDYNAMICS. Prigogine, I.; Henin, F. (Univ. Libre, Brussels). pp 356-64 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

Brief mention is made of how kinetic equations may be obtained as the asymptotic equations that describe the evolution of systems such that the collision and relaxation time scales are widely different and such that initial correlations are rapidly forgotten. However, even when the first condition is satisfied, the second one is not necessarily fulfilled. The interaction between light and a three-level atom is considered to illustrate a new approach towards kinetic equations. The basic idea is a decomposition of the dynamics in a sum of subdynamics. Each subdynamics corresponds to the evolution of the projection of the density matrix on a well-defined subspace. Kinetic equations may be established in each subspace. One of them is the usual kinetic equation that describes the approach to equilibrium while the others describe the destruction of initial correlations. The relation between the dynamical and the thermodynamical description of a many-body system may be understood in this framework. (auth)

49287 QUANTUM-STATISTICAL MECHANICS OF INFINITE SYSTEMS. Haag, R. (Institute fuer Theoretische Physik, Ham-

burg). pp 379-85 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

A brief survey is given of some recent work by various authors concerning an approach to statistical mechanics in which the thermodynamic limit is taken at the outset, i.e., the system is idealized to be infinitely extended. One considers the algebra of "local operations" on the system. The physical states of the system are a certain subset of the expectation functionals over this algebra. Of particular interest among these states are the thermodynamic equilibrium states, the ergodic states with respect to a group, the states tend towards equilibrium for large times, and those that tend at least to a "local equilibrium" everywhere. A satisfactory characterization of these last-mentioned classes of states is not available at this time but partial results exist. (auth)

49288 FUNCTIONAL METHOD IN QUANTUM STATISTICS AND THE MANY-BODY PROBLEM. Fradkin, E. S. (Lebedev Inst. of Physics, Moscow). pp 386-414 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

A continuum solution is obtained for the Green function in an external field in statistics. Various approximations of this solution are considered. A functional solution is found for the statistic sum and the generating functional of the Green statistic functions of relativistic systems with arbitrary interaction. The solution for the Ising model is considered. A functional formulation is given for systems having broken symmetry solutions. (auth)

49289 EINFUEHRUNG IN DIE QUANTENMECHANIK UND IHRE ANWENDUNGEN. (Introduction to Quantum Mechanics and Its Application). Gombas, P.; Kisdi, D. Vienna; Springer-Verlag (1970). 251p. $12.25.

Basic principles of quantum mechanics are treated and a short survey is given on Bohr's quantum theory. The second section deals with numerous practical applications, such as the single particle problem, the scattering problem, and approximation methods applied to simple problems. Calculation methods applied in wave mechanics are explained and performed with details for use of self-study. (H.B.G.)

49290 SUPERSTABLE INTERACTIONS IN CLASSICAL STATISTICAL MECHANICS. Ruelle, D. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Commun. Math. Phys.; 18: 127-59(1970).

Classical systems of particles are considered in ν dimensions. For a very large class of pair potentials (superstable lower regular potentials) it is shown that the correlation functions have bounds of the form $\rho(x_1, \ldots, x_n) \leq \xi^n$. Using these and further inequalities one can extend various results obtained by Dobrushin and Minlos for the case of potentials which are nonintegrably divergent at the origin. In particular, it is shown that the pressure is a continuous function of the density. Infinite system equilibrium states are also defined and studied by analogy with the work of Dobrushin and of Lanford and Ruelle for lattice gases. (auth)

49291 QUANTUM FLUIDS. Proceedings of the Batsheva Seminar Held at Haifa, Israel, July 28-August 16, 1968. Wiser, Nathan; Amit, D. J. (eds.). New York; Gordon and Breach, Science Publishers, Inc. (1970). 624p. $47.50. (CONF-680731).

Papers are included on the following topics: superfluidity—the paradox of atomic simplicity and remarkable behavior; field theoretic methods in the many-body problem; phenomenological theory of superconductivity; introduction to the theory of superconductivity—the pair wave function order parameter; type-II superconductors; theory of Fermi liquids; liquid ^{4}He; formalism of linear response in many-body systems; the T-matrix approximation; experimental studies from a microscopic point of view: ions, vortices, and "excitons"; selected problems in sound propagation in liquid helium; the theory of liquid helium; low-temperature expansion of relation times in Fermi liquids; the superfluidity of liquid ^{3}He; dilute mixtures of ^{3}He in liquid ^{4}He at low temperatures; the superconducting phase transition—fluctuations and paraconductivity; the influence of impurities and boundary effects on transitions in superconductivity; spin fluctuations in almost magnetic materials and the Kondo effect; statistical-mechanical approach to the theory of quantum fluids; the kq representation; the Hartree-Fock problem with subsidiary conditions and the random phase approximation; symmetry breaking in the superfluid condensation; the energy and stability of vortex rings in liquid helium II—critical velocities; the effect of orbital quantization on the critical field of type-II superconductors; the transport properties of pure type-II superconductors near H_{c_2}; magnetization in superconducting films; damping of helicons in a metal with anisotropic Fermi surface; and a self-consistent pairing theory of the Bose superfluid. (M.H.R.)

49292 PLANAR SOLUTIONS OF THE DIRAC-HESTENES EQUATION IN A CENTRAL FIELD. Casanova, Gaston. Compt. Rend., Ser A; 270: 1470-2(1 Jun 1970). (In French).

Studies of the planar solutions of the Dirac-Hestenes equations indicate notable differences with the usual interpretation of the spherical solutions of the Dirac equation concerning orbital momentum and spin. Furthermore, the general solutions applicable to adjacent hydrogenic and antihydrogenic atoms can be predicted. (tr-auth) (France)

49293 PARTICLE IDENTIFICATION AND SUBSIDIARY CONDITIONS FROM CORRELATION FUNCTIONS. Shankland, Donn G. (Air Force Inst. of Tech., Wright Patterson Air Force Base, Ohio). Amer. J. Phys.; 38: 1239-44(Oct 1970).

A tensor field of any rank can be separated into its fundamental particles by considering the possible forms of its correlation function in momentum space. The constraint equations necessary to project particles of one type can be obtained from the eigenvectors of the correlation matrix. (auth)

49294 RESONANCE ACCELERATION OF PARTICLES IN A MAGNETIC FIELD BY A PLANE WAVE WITH A PHASE VELOCITY GREATER THAN THE VELOCITY OF LIGHT. Voronin, V. S.; Kononov, V. K. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 115-17 (Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 160-3(Jan 1970).

The distribution of a magnetic field is determined in which it is possible for a charged particle to undergo resonance acceleration by the field of a plane electromagnetic wave with a phase velocity greater than the velocity of light. (auth)

49295 LIMITING-OSCILLATION AMPLITUDES OF A MULTIVELOCITY ELECTRON BEAM IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Korsunskii, A. M.; Khizhanyak, N. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 53-6(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 77-82(Jan 1970).

A system of N electron beams with unperturbed densities ρ_{i0} ($i = 1, 2 \ldots N$) and unperturbed velocities v_{i0} is investigated in which the beams move at an angle θ to the direction of an external magnetic field H_0. The development of longitudinal oscillations and the buildup of stationary oscillations for such a system are studied. A square-law dependence of the maximum oscillation amplitudes on the beam parameters, the growth rate, and the angle θ is obtained. It is shown that the beam trajectories do not intersect in the range of parameters under consideration. (auth)

49296 INTEGRAL EQUATION FORMULATION OF ONE-DIMENSIONAL QUANTUM MECHANICS. James, Philip B. (Univ. of Missouri, St. Louis). Amer. J. Phys.; 38: 1319-23(Nov 1970).

The transformation of the one-dimensional Schroedinger equation to an integral equation is described. Several interesting problems are analyzed using this formulation. (auth)

49297 POSSIBLE NEW TYPE OF MOLECULAR BOUND STATE. Rosenfield, Joan; Voigt, Bjoern; Mead, C. Alden (Univ. of Minnesota, Minneapolis). J. Chem. Phys.; 53: 1960-9(1 Sep 1970).

It is shown that the corrections to the Born-Oppenheimer approximation may lead to the appearance of a new type of bound state, the theory of which is mathematically analogous to that of Cooper pair states in superconductivity theory. Some of the properties of these states, and the conditions for their existence, are studied for the special case of diatomic molecules. In all cases of interest, one such state at most can appear below the continuum threshold belonging to the ground electronic state of the molecule, i.e., they have no rotational or vibrational structure. In the case most likely to arise, the binding energy, considered as a function of the Born-Oppenheimer expansion parameter κ, has an essential singularity at zero, so the state could never have been discovered by the power-series expansion method. Experimental observation of these states is expected to be difficult since their wavefunctions do not differ importantly from those for ordinary bound states of the same energy. However, the theory predicts that an accurate Born-Oppenheimer calculation of the number of bound states should sometimes be too low by one, and the isotope effect on the binding energy is different from that of ordinary bound states. (auth)

49298 PHASE AMBIGUITY IN THE LADDER OPERATOR SOLUTION OF THE HARMONIC OSCILLATOR. Alldredge, Gerald P. (Univ. of Texas, Austin). Amer. J. Phys.; 38: 1357-9(Nov 1970).

It is pointed out how the phase ambiguity arises, and how it propagates through some of the standard formulas. It is shown how a mnemonic diagram representation of the ladder operators can aid in obtaining the correct phase. (J.F.P.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 49354, 49356, 49659, and 49660.

49299 (BMBW-FBK-70-9) ANNUAL REPORT, 1969. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Jul 1970. 80p. (In German). Dep. CFSTI (U. S. Sales Only).

At the II. Institut für Elementarphysik a number of research groups are working on nuclear and elementary particle physics. A further group does solid state physics using the synchrotron radiation of DESY. In nuclear physics, mainly reaction mechanisms, nuclear moments, and hyperfine interactions are studied. The experiments are performed by means of a 3 MeV van de Graaff generator, a 30 MeV-isochronous cyclotron, and radioactive sources. Elementary particle physics is done in tight connection with research groups at DESY. Research is focussed on production processes and reaction mechanisms of elementary particles. (auth)

Electromagnetic

Refer also to abstract 49569.

49300 (LNF-70/39) ASYMMETRY IN SINGLE π^0 PHOTOPRODUCTION BY POLARIZED γ-RAYS ON PROTONS. Note No. 490. Bologna, G.; Fabbri, F. L.; Spillantini, P.; Valente, V. Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 29 Jul 1970. 4p. (CONF-700806-37). Dep. CFSTI (U. S. Sales Only).

From 15th International Conference on High Energy Physics, Kiev, USSR.

The asymmetry ratio for the process $\gamma + p \rightarrow \pi^0 + p$ by linearly polarized γ-rays is reported for $E_\gamma = 280$ to 600 MeV and for a π^0 production angle in the c.m. system $\theta^* = 90°$. (auth)

49301 PHOTOPRODUCTION OF VECTOR MESONS AND $\Delta(1238)$ IN HYDROGEN AND DEUTERIUM AND THE $\rho\pi\gamma$ WIDTH. Eisenberg, Y.; Haber, B.; Ronat, E. E.; Shapira, A.; Yekutieli, G. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev. Lett.; 25: 764-7(14 Sep 1970).

In a study of the photoproduction reactions $\gamma p \rightarrow \rho^- \Delta^{++}$ and $\gamma n \rightarrow \omega^0 \Delta^0$ at 4.3 GeV, a substantial cross section, 1.8 ± 0.4 μb, for the first reaction and an upper limit of 0.5 μb for the second are obtained. If one-pion exchange dominates the above reactions, then by SU(3) one predicts $\omega^0\Delta^0 : \rho^-\Delta^{++} = 2:1$. It is believed that the discrepancy between theory and experiment is due to exchanges other than π mesons contributing to charged ρ photoproduction, thus making the derivation of $\Gamma(\rho\pi\gamma)$ from it rather unreliable. (auth)

49302 PHOTOPRODUCTION OF POSITIVE PIONS ON HYDROGEN AT PHOTON ENERGIES BETWEEN 220 AND 425 MeV. Fischer, G.; Fischer, H.; Heuel, M.; von Holtey, G.; Knop, G.; Stumpfig, J. (Univ., Bonn). Nucl. Phys.; B16: 119-24(1970).

Differential cross sections for π^+ photoproduction on hydrogen were measured over a photon energy range from 220 to 425 MeV and for pion cm angles between 15° and 70°. The pions were analyzed in angle and momentum by a magnetic spectrometer. (auth)

49303 PHOTOPRODUCTION OF NEUTRAL PIONS ON HYDROGEN AT PHOTON ENERGIES BETWEEN 200 AND 440 MeV. Fischer, G.; Fischer, H.; Von Holtey, G.; Kaempgen, H.; Knop, G.; Schulz, P.; Wessels, H.; Braunschweig, W.; Genzel, H.; Wedemeyer, R. (Univ., Bonn). Nucl. Phys.; B16: 93-101 (1970).

Differential cross sections for neutral-pion photoproduction on hydrogen in the region of the first resonance were measured by two independent experiments detecting the recoil protons. The results of both measurements were combined into one set of cross sections covering the photon energy range from 200 to 440 MeV at pion c.m. angles between 50 and 160 degrees. (auth)

49304 SEARCH FOR THE PROCESS $e^- + e^- \rightarrow \mu^- + \mu^-$. Cheng, David Cheekit. Princeton, N. J.; Princeton Univ. (1969). 100p. University Microfilms Order No. 70-8354.

Thesis.

In order to make a sensitive test of whether a multiplicative or an additive lepton number conservation law is at work in leptonic reactions, the process $e^- + e^- \rightarrow \mu^- + \mu^-$ was searched for using colliding beams. In 114 hours of beam-interacting-time, 1 event was identified as a possible candidate for the reaction. The background was estimated as less than 1 event. The result of the experiment sets an upper limit on the cross section of 0.8×10^{-32} cm^2. A phenomenological Hamiltonian describing a point interaction of strength G can be introduced for the process. Using this Hamiltonian, it was concluded that such a coupling, if existing, is no stronger than 670 times the universal coupling constant of weak interactions. The experiment has improved the limit on this coupling by a factor equivalent to 100 in the cross section. (Diss. Abstr.)

49305 COMPARISON OF THE K/π RATIO IN MULTIPLE PRODUCTION AT ENERGIES OF 60 AND ~1000 GeV. Babecki, J. (Inst. of Nuclear Physics, Krakow); Furmanska, B. Lett. Nuovo Cim.; 4: 521-4(19 Sep. 1970)..

A comparison is made of the K/π ratios in cosmic-ray jets with primary energy of 1000 GeV and ratios in accelerator jets of 60 GeV. Nuclear emulsions are used for both studies. The modified Peryou plot is used in this comparison. The K/π ratio is found to be 1.50 ± 0.62 for cosmic-ray jets and 0.24 ± 0.10 for accelerator jets. (J.F.P.)

Weak

49306 (NEVIS-184) $K_L - K_S$ REGENERATION AMPLITUDE IN COPPER AT 2.5 GeV/c AND CP NON-INVARIANCE. Bennett, Sheldon (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1970. Contract AT(30-1)-1932. 131p. (CU-288; R-720). Dep. CFSTI.

Thesis.

The $K_L - K_S$ regeneration amplitude $i(f - \bar{f})/p$ is measured in copper at 2.5 GeV/c. The phase, $\phi_f = \text{Arg}[i(f - \bar{f})/p]$, is determined from the time dependence of the charge asymmetry in the decay $K \rightarrow e^+ + \pi^- + \nu$ following passage of a K_L beam through 30.5 cm of converter. The value $\phi_f = (-49.7 \pm 7.8)^0 - 200^0 \times [(\Delta m/\gamma_s) - 0.469]$ is obtained on the basis of 797,000 events. Supplementary measurements of the relative $\pi^+\pi^-$ intensity yield $|f - \bar{f}|/p = (2.55 \pm 0.15) \times 10^{-28}$ cm^2. An alternative value $\phi_f = \pm(50.1 \pm 7.6)^0$ is obtained from cross section data and the value of $|f - \bar{f}|/p$. The combined value is $\phi_f = (-49.9 \pm 5.4)^0 - 95^0 \times [(\Delta m/\gamma_s) - 0.469]$. Denoting by x the ratio of $\Delta S = \Delta Q$ rule violating to conserving amplitudes, the value $(1 - |x|^2)/|1 + x|^2 = 0.96 \pm 0.05$ is obtained from the magnitude of the charge asymmetry and the value of $|f - \bar{f}|/p$. Combining the values of ϕ_f and $(1 - |x|^2)/|1 + x|^2$ with existing measurements of 2π interference and the charge asymmetry in the leptonic decay of K_L yields values of $\phi_+ = \text{Arg}(\eta_+)$ and Reϵ consistent with the superweak model. (auth)

49307 EXPERIMENTAL LIMIT ON $\nu_\mu + e^- \rightarrow \nu_\mu + e^-$ AND THE EXISTENCE OF WEAKLY COUPLED NEUTRAL LEPTON CURRENTS. Albright, Carl H. (Northern Illinois Univ., DeKalb, Ill.). Phys. Rev., D; 2: 1330-1(1 Oct 1970).

A recent analysis by Steiner of the CERN neutrino spark-chamber experiment is employed to derive an upper limit on the elastic cross section for $\nu_\mu - e^-$ scattering. The limit obtained is just at a level consistent with the theoretical cross section predicted for neutral lepton currents coupled to form a weak isospin-invariant Hamiltonian. (auth)

49308 BRANCHING RATIOS FOR $K^+ \rightarrow 3\pi$ DECAYS. Pandoulas, D. (Stevens Inst. of Tech., Hoboken, N. J.); Taylor, S.; Koller, E. L.; Grauman, J.; Hoffmaster, S.; Raths, O.; Romano, L.; Stamer, P. Phys. Rev., D; 2: 1205-11(1 Oct 1970).

The branching ratios $\tau'^+/(K^+ \rightarrow \text{all})$ and τ'^+/τ^+ were obtained from a sample of 12 976 K^+ decays including 198 τ'^+ and 693 τ^+ decays. It was found that $\tau'^+/(K^+ \rightarrow \text{all}) = 0.0153 \pm 0.0011$, and that $\tau'^+/\tau^+ = 0.286 \pm 0.023$. The $\tau^+/(K^+ \rightarrow \text{all})$ branching ratio and the π^+ energy spectrum in τ'^+ decay were also obtained, and were found to be in good agreement with the more precise determinations of the other experiments. The branching-ratio data suggest a small $\Delta I = \frac{1}{2}$ admixture in the $K \rightarrow 3\pi$ decay amplitudes. Comparison with various theoretical models shows fair to good agreement between experiment and theory. (auth)

49309 NON-MESONIC DECAY OF HELIUM HYPERNUCLEI. Coremans, G. (Univ. Libre, Brussels); Sacton, J.; O'Sullivan, D.; Esmael, F.; Davis, D. H.; Shaukat, M. A.; Pniewski, T.; Allen, J. E. Nucl. Phys.; B16: 209-20(1970).

The analysis is reported of a sample of hypernuclei decaying non-mesonically with the emission of one or two charged particles which were obtained from K^- meson captures at rest in nuclear

emulsion. Making use of the decay parameters established for the ${}^{4}_{\Lambda}$He hypernucleus from observations in a helium bubble chamber, a value of Q^-, the ratio of non-mesonic to π^- mesonic decays, for ${}^{4}_{\Lambda}$He together with the rates of certain decay modes have been determined. (auth)

49310 BRANCHING RATIOS FOR THE π^- MESONIC DECAYS OF THE HYPERNUCLEI ${}^{3}_{\Lambda}$H AND ${}^{4}_{\Lambda}$H. Bertrand, D. (Univ. Libre, Brussels); Coremans, G.; Mayeur, C.; Sacton, J.; Vilain, P.; Wilquet, G.; Wickens, J. H.; O'Sullivan, D.; Davis, D. H.; Allen, J. E. Nucl. Phys.; B16: 77-84(1970).

Results are presented concerning the experimental determination, with large statistics, of the branching ratios for the π^- mesonic decay of the hypernuclei ${}^{3}_{\Lambda}$H and ${}^{4}_{\Lambda}$H. The spin assignments $J({}^{3}_{\Lambda}H) = \frac{1}{2}$ and $J({}^{4}_{\Lambda}H) = 0$ are confirmed. (auth)

49311 ON THE LIFETIME OF THE ${}^{3}_{\Lambda}$H HYPERNUCLEUS. Bohm, G. (Institut fuer Hochenergiephysik, Berlin); Klabuhn, J.; Krecker, U.; (and others). Nucl. Phys.; B16: 46-52(1970).

The mean lifetime of the ${}^{3}_{\Lambda}$H hypernucleus was estimated in nuclear emulsion using the $(\pi^- + {}^{1}H + {}^{2}H)$ decays both at rest and in flight. The result, $\tau({}^{3}_{\Lambda}H) = (1.28) \cdot 10^{-10}$ sec, is significantly lower than another recent experimental value and the theoretical predictions. A possible explanation of the discrepancy with the theoretical predictions is briefly discussed. (auth)

49312 MEASUREMENT OF THE LEPTONIC BRANCHING RATIOS OF THE CHARGED SIGMA HYPERON. Loveless, Richard John. Stony Brook, N. Y.; State Univ. of New York (1969). 125p. University Microfilms Order No. 69-17,302. Thesis.

The leptonic branching ratios of the Σ^+ hyperon were determined from a study of 550,000 pictures of stopping K^- mesons in the 30" hydrogen bubble chamber at Brookhaven National Laboratory. The film was double-scanned by Stony Brook and Columbia University in collaboration. Leptonic events were identified by observing the decay of a Σ^+ hyperon into an obvious electron (positron) or a muon which subsequently decays into an obvious electron. $\Sigma^+ \rightarrow Ae^+\nu$ decays were also identified by the visible A decay into protons and π^-. All leptonic candidates were measured and the $\Sigma - \Lambda$ events were fitted to a complete chain of production and decay reactions. There were 2.13×10^6 Σ^- hyperons and $.99 \times 10^6$ Σ^+ hyperons produced on the film. After geometric restrictions there were 62 $\Sigma^- \rightarrow ne\nu$ events, 31 $\Sigma^- \rightarrow Ae^-\nu$ events, 9 $\Sigma^- \rightarrow n\mu^-\nu$ events, and 5 $\Sigma^+ \rightarrow Ae\nu$ events. Hence the ratio $\Sigma^- \rightarrow ne\nu$/all Σ^- decays is found to be $0.97 \pm 0.15 \times 10^{-3}$; the ratio $\Sigma^- \rightarrow Ae\nu$/all Σ^- decays is $.52 \pm 0.09 \times 10^{-4}$; the ratio $\Sigma^+ \rightarrow Ae^+\nu$/all Σ^+ decays is $0.16 \pm 0.07 \times 10^{-4}$; and the ratio $\Sigma^- \rightarrow n\mu^-\nu$/all Σ^- decays is $0.38 \pm 0.11 \times 10^{-4}$. No evidence is found for $\Delta S = \Delta Q$ violations and an upper limit for the ratio of $\Gamma(\Sigma^+ \rightarrow ne\nu)/\Gamma(\Sigma^- \rightarrow ne^-\nu)$ was determined to be 12.6% with 95% confidence. (Diss. Abstr.)

Strong (Baryon-Induced)

49313 (COO-2009-15) LARGE ANGLE PROTON-PROTON ELASTIC SCATTERING AT INTERMEDIATE MOMENTA. Neal, H. A.; Brabson, B. B.; Crittenden, R. R.; Heinz, R. M.; Kammerud, R. C.; Paik, H. W.; Sidwell, R. A. (Indiana Univ., Bloomington). [1970]. Contract AT(11-1)-2009. 36p. (CONF-700806-38). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

Differential cross sections were measured for large-angle p-p elastic scattering at intermediate momenta at the Argonne ZGS Accelerator. The measurements cover the momentum range 1.5 to 5.5 GeV/c and the angular region $40 \leq \theta_{cm} \leq 90°$. The statistical accuracy of the data, presented in bins of 2° in θ_{cm}, is typically ±4%. Fixed θ_{cm} cross sections suggest slope changes near $t = -.8$ and -3 $(GeV/c)^2$. Optical model and Regge pole model analyses of the data are presented. (auth)

49314 (NYO-3651-14) STUDY OF $\Sigma^- + p \rightarrow \Lambda + n$ AND $\Sigma^0 + n$ REACTIONS USING POLARIZED Σ^- WITH MOMENTUM FROM 0 TO 650 MeV/c. Stephen, D.; Hertzbach, S. S.; Kofler, R. R.; Meisner, G. W.; Yamamoto, S. S. (Massachusetts Univ., Amherst). [1970]. Contract AT(30-1)-3651. 15p. Dep. CFSTI.

$\Sigma^- + p \rightarrow \Lambda + n$ and $\Sigma^0 + n$ interactions were studied at $0 \leq P_{\Sigma^-} \leq 650$ MeV/c. The capture ratio r is measured to be $.460 \pm .011$ at $P_\Sigma = 0$. The $\Sigma^- - \Lambda$ polarization correlation indicates dominant ${}^3S_1$ state at $P_\Sigma = 0$. The cross sections indicate enhancements at $P_\Sigma = 440$ and $P_\Sigma = 570$ MeV/c. (auth)

49315 (PURC-4159-7) DIRECT MEASUREMENT OF n-p AND n-d TOTAL CROSS SECTIONS FROM 700 MeV/c TO 2900 MeV/c. Mischke, R. E. (Princeton Univ., N. J.); Devlin, T. J.; Ehrlich, R.; Johnson, W.; Norem, J.; Vosburgh, K. (Rutgers-The State Univ., New Brunswick, N. J.); Schimmerling, W. (Princeton-Pennsylvania Accelerator, Princeton, N. J. Rutgers-The State Univ., New Brunswick, N. J.). Aug 1970. 9p. (CONF-700806-32). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

Neutron-proton and neutron-deuteron total cross sections have been measured directly at the Princeton-Pennsylvania Accelerator using time of flight to determine the incident neutron energy. The results cover the region from 700 MeV/c to 2900 MeV/c with accuracy of 0.8%. The effect of the D*(2180) is clearly seen. Comparisons are made with p-p and p-d measuremenis in the same energy range. (auth)

49316 INVESTIGATION OF THE $\bar{p}d\pi^+\pi^-$ FINAL STATE IN $\bar{p}d$ COHERENT PRODUCTION AT 5.5 GeV/c. Braun, H.; Evrard, D.; Fridman, A.; Gerber, J.-P.; Maurer, G.; Michalon, A.; Schiby, B.; Strub, R.; Voltolini, C. (Centre de Recherches Nucleaires, Strasbourg). Phys. Rev., D; 2: 1212-19(1 Oct 1970).

From 150,000 photographs taken with the 30-in. ANL bubble chamber, a sample of $\bar{p}d \rightarrow \bar{p}d\pi^+\pi^-$ events was obtained, yielding a cross section of 0.22 ± 0.02 mb. The reaction is dominated by $\bar{\Delta}^{--}(1236)$ production. A low-mass enhancement in the $d\pi^+$ mass spectrum appears at 2.2 GeV/c^2. This bump is interpreted as being due to a final-state interaction, treated as elastic scattering. The first-order impulse approximation and πN phase shifts were used, which give a satisfactory description of the πd elastic scattering data at low energy. A good description of the $d\pi^+$ mass spectrum is obtained. A peripheral model with a Reggeized π exchange which scatters off the deuteron was also considered. Using this model and peripheral phase space, a simultaneous fit on the $d\pi^+$ and $\bar{p}\pi^+\pi^-$ mass distributions was made successfully. The angular distribution of the outgoing deuteron in the π^+d c.m. frame is also well described. (auth)

49317 $\bar{p}p$ ELASTIC SCATTERING IN THE MOMENTUM RANGE 1.24 TO 1.62 GeV/c. Cooper, W. A.; Hodges, D.; Hyman, L.; Jach, T.; Loken, J.; Manner, W.; Musgrave, B.; Royston, R. (Argonne National Lab., Ill.). Nucl. Phys.; B16: 155-60(1970).

The $\bar{p}p$ elastic cross section was measured at incident antiproton momenta of 1.24, 1.32, 1.54, and 1.62 GeV/c to be 43.2 ± 3.5, 43.3 ± 3.0, 38.5 ± 3.0, and 37.2 ± 3.0 mb respectively. The differential cross section in this momentum range is dominated by a diffraction peak for which the slope is found to decrease with incident momentum, consistent with the established "anti-shrinkage" of the $\bar{p}p$ diffraction peak [3]. The differential cross section shows a well-defined dip at $\cos\theta_{c.m.} \approx 0.4$ followed by a broad maximum and a sharp backward peak largely confined to the interval $\cos\theta_{c.m.} < -0.8$. (auth)

49318 GENERAL CHARACTERISTICS OF THE ANNIHILATION REACTION $\bar{p}p \rightarrow 3\pi^+3\pi^-(\pi^0)$ AT 3.6 GeV/c. Atherton, H. W. (CERN, Geneva); Blair, W. M. R.; Celnikier, L. M.; (and others). Nucl. Phys.; B18: 221-45(1970).

In the reaction $\bar{p}p \rightarrow 3\pi^+3\pi^-$ 2227 events, and in the reaction $\bar{p}p \rightarrow 3\pi^+3\pi^-\pi^0$ 6578 events were analyzed. The general characteristics of the reactions, such as total cross sections, angular and momentum distributions, the production of ρ, f, ω and η mesons, and angular correlations are presented. The well-known tendency of charged pions to follow the line of flight of baryons of the same charge (forward peaking) is observed. In addition, the angular distributions show a significant backward peak for pions of high momenta in the c.m. system. These effects are compared with the results of a multiperipheral model with nucleon exchange (modified CLA). Copious ρ^+, ρ^0, p^0, and ω-production is found with an average of more than one resonance per event, $\rho^0\omega$ associated production is evaluated. The angular distributions of the ρ^0 and ω are given and are found to be more anisotropic than for the individual pions. The angular correlations are successfully described by phase space modified for the observed resonance production and Bose-Einstein symmetrization. (auth)

49319 TWO AND THREE PION PRODUCTION IN pp COLLISIONS AT 6.92 GeV/c. Yekutieli, G. (Weizmann Inst. of Science, Rehovoth, Israel); Toaff, S.; Shapira, A.; (and others). Nucl. Phys.; B18: 301-31(1970).

Cross sections are given for the main processes contributing to the final states $pp\pi^+\pi^-$, $pp\pi^+\pi^-\pi^0$ and $pn\pi^+\pi^+\pi^-$. In all reactions $N^*(1238)$ is observed to be strongly produced. For these three reactions the baryons are strongly forward/backward peaked in the c.m. The reaction $pp \rightarrow N^{*++}(1238)p\pi^-$ was examined in some detail, and compared with the predictions of various peripheral models. As is already well known, the Ferrari-Selleri model is inadequate, but when some of the effects of absorption are included, the agreement with the data is considerably improved. The alternative of replacing the propagator corresponding to elementary pion exchange by that for a Regge exchange also gives good agreement with experiment. Finally we have tested a double-

Regge-exchange model and found that its prediction for one of the Treiman-Yang angles is unsatisfactory. A discussion is also given of a classification in which events are divided into categories depending on which particles are emitted in the same hemisphere. The two groupings $p(p\pi^+\pi^-)$ and $(p\pi^+)(p\pi^-)$ each accounts for approximately half of the $pp\pi^+\pi^-$ final state. The final states $pp\omega$, $pp\eta$ and possibly $pp\rho^0$ are observed, and cross sections are compared with values obtained at other momenta. An attempt to deduce the reaction mechanism from the longitudinal momentum plot is discussed in an appendix. (auth)

49320 ANTIPROTON–PROTON ANNIHILATION INTERACTIONS AT 2.7 GeV/c PRODUCING EIGHT OR MORE PIONS. Fisher, G. P.; Libby, L. M. (Univ. of Colorado, Boulder). Nucl. Phys.; B16: 450-60(1970).

Eight- and ten-pronged events from 2.7 GeV/c $\bar{p}p$ interactions are studied. Multipion cross sections, invariant-mass distributions and angular distributions are measured. With the exception of pion-pion angular correlations, all of our data are consistent with the simple statistical model (Lorentz-invariant phase space). The pion-pion angular correlations are significantly different from phase space for different dipion charge combinations. Pions having like charges tend to have the same direction. One might expect that Bose–Einstein statistics is responsible for the angular correlation but the lack of significant correlation between the pion momenta and the opening angle puts it in doubt. (auth)

49321 ANTIPROTON–PROTON ANNIHILATIONS INTO π^- AND K-MESONS AT 5.7 GeV/c. Atherton, H. W. (CERN, Geneva); Franek, B. J.; French, B. R.; (and others). Nucl. Phys.; B16: 416-30(1970).

12367 events from antiproton-proton annihilations into kaons and pions were analyzed. Partial cross sections are determined for various $K\bar{K} + n\pi(n = 0,1,2\ldots)$ final states and the total cross section is found to be 3.5 ± 0.3 mb. The angular and the momentum distributions are presented and compared with the predictions of theoretical models. Strong production of $K^*(890)$ ($K^{*\pm}$ favored) is observed (0.7 K^*/event). In the cm, the $K^{*+}(K^{*-})$ are collimated along the incident proton (antiproton) direction. (auth)

49322 OBSERVATION OF A Δ^{++} (~1900) RESONANCE DECAYING INTO $\Delta^{++}(1236)\pi^-\pi^+$. Boeggild, H. (Univ. of Copenhagen); Hansen, K.; Johnstad, H.; (and others). Nucl. Phys.; B16: 503-7(1970).

Production of $\Delta^{++}(\approx 1900)$ was observed in the reaction $pp \rightarrow \Delta^{++}(\approx 1900)n$. The observed decay mode is $\Delta^{++}(\approx 1900) \rightarrow \Delta^{++}(1236)\pi^-\pi^+$. The cross section for the process multiplied by the branching ratio of the observed decay mode is 29 ± 7 μb. There is no indication of the decay mode $\Delta^{++}(\approx 1900) \rightarrow \Delta^{++}(1236)\ \rho^*(765)$. (auth)

49323 HYPERON–PROTON INTERACTIONS BETWEEN 0.5 AND 4.0 GeV/c. Charlton, G. R. (Ecole Polytechnique, Paris); Badier, J.; Barrelet, E.; Makarovisch, L.; Pernegr, J.; Hubbard, J. R.; Leveque, A.; Louedec, C.; Moscoso, L.; Revel, D. Phys. Lett.; 32B: 720-2(14 Sep 1970).

Hyperon-proton interactions were studied in a 12 event/μb exposure of the CERN 2m hydrogen bubble chamber to a 3.95 GeV/c K^- beam. Results concerning 192 elastic and 52 inelastic Λp interactions, as well as 43 Σ and Ξ elastic scatters were reported. The hyperons were produced with momenta between 0.5 and 4.0 GeV/c. (auth)

Strong (Meson-Induced)

Refer also to abstracts 48216, 49508, and 49703.

49324 (COO–2069-14) π^+p BACKWARD ELASTIC SCATTERING FROM 2.18 TO 5.25 GeV/c. Sidwell, Ronald Arden (Indiana Univ., Bloomington. Dept. of Physics). [1970]. Contract AT(11-1)-2069. 98p. Dep. CFSTI.

Differential cross sections are presented for pion-proton elastic scattering in the angular range $-0.6 \gtrsim \cos\theta_{c.m.} \gtrsim -0.98$ at 15 incident π^+ momenta from 2.18 to 5.25 GeV/c and five incident π^- momenta from 2.38 to 3.00 GeV/c. The π^+p angular distributions rise steeply near 180° at all momenta. For laboratory momenta ≳2.75 GeV/c they show a minimum at $u \approx -0.17$ $(GeV/c)^2$ and a broad maximum near $u \approx -0.5$ $(GeV/c)^2$, where u is the square of the four momentum transfer between the incoming pion and outgoing proton. The structure of the π^-p angular distributions undergoes a marked change in the momentum range studied. A pronounced dip in the cross section at 180° which is observed at momenta ≲2.50 GeV/c evolves into a steeply rising peak at 2.80 and 3.00 GeV/c. A minimum in the differential cross sections appears in the 3.00 GeV/c data at $\theta_{c.m.} \approx 155°$. A shallow minimum is indicated for all momenta near $\theta_{c.m.} \approx 135°$. Qualitatively good agreement with the experimental results is obtained with a direct channel resonance model. The π^+p data are compared with a Regge model which considers the exchange of the Δ_δ and N_α Regge trajectories. The qualitative success of both the direct channel resonance model and the Regge model lends support to the concept of quality. (auth)

49325 (UCRL–19865) THE A_2 AND THE 2^+ NONET. CONSISTENCY OF DATA. Barbaro-Galtieri, Angela (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1970. Contract W-7405-eng-48. 27p. (CONF-700525-7). Dep. CFSTI.

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa.

New data on the A_2^+ meson fail to show the two-peak structure seen in the A_2^- experiments of the CERN group. All the bubble chamber experiments on A_2 production are reviewed and the new data are compared with the CERN data. The two-parameter double-pole formula used to fit the CERN data does not appear to explain the new data. Therefore the only way to reconcile the various experiments on the charged A_2 is to assume the presence of two coherently produced resonances with $J^P = 2^+$, with a phase depending on either the charge of the incoming beam, or the momentum transfer to the target proton, or the incident momentum, or all three. The K*(1420) and the f meson, members of the same 2^+ nonet as the A_2, do not seem to show any structure consistent with the two-parameter double-pole formula. (auth)

49326 (UCRL–20039) NEUTRAL DECAYS OF THE η^0 MESON. Risser, Thomas Bard (California Univ., Berkeley. Lawrence Radiation Lab.). 1 Aug 1970. Contract W-7405-eng-48. 145p. Dep. CFSTI.

Thesis.

Eta mesons were produced by the reaction $\pi^-p \rightarrow \eta^0n$. Veto counters surrounding the hydrogen target in which this interaction takes place eliminate all reactions involving charged particles. The neutral decays of the eta meson are studied with a cubical array of lead plate spark chambers for the conversion of gamma rays. The eta producing reaction is identified by the time of flight of the neutron from the hydrogen target. The neutron is detected by one of twenty large scintillation counters. It is found that the data are consistent with zero decays of the type $\eta^0 \rightarrow \pi^0\gamma\gamma$. With the assumption that only the neutral decays $\eta^0 \rightarrow \gamma\gamma$ and $\eta^0 \rightarrow 3\pi^0$ are present, it is found that $[R(\eta^0 \rightarrow \gamma\gamma/\eta^0 \rightarrow \text{all neutrals})] = 0.580 \pm 0.013$ and $[R(\eta^0 \rightarrow 3\pi^0/\eta^0 \rightarrow \text{all neutrals})] = 0.420 \pm 0.015$. Furthermore, with 95% confidence $[R(\eta^0 \rightarrow \pi^0\gamma\gamma/\eta^0 \rightarrow \text{all neutrals})] < 0.061$. (auth)

49327 DOUBLE-REGGE-POLE ANALYSIS OF $\pi^+p \rightarrow \pi^+\rho^0p$ AT 13.1 GeV/c. Gaidos, J. A.; Ezell, C. R.; Lamsa, J. W.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 2: 1226-34(1 Oct 1970).

A double-Regge-exchange analysis of the reaction $\pi^+p \rightarrow \pi^+\rho^0p$ at 13.1 GeV/c is presented. The events are divided into proton diffractive (~80%) and pion diffractive (~20%) categories, each of which requires two double-Regge amplitudes for a complete description. The data of each sample are well described by a double-Regge model consistent with duality. (auth)

49328 NEUTRON POLARIZATION IN π^-p CHARGE-EXCHANGE SCATTERING AT 310 MeV. Hill, R. E.; Booth, N. E.; Esterling, R. J.; Jenkins, D. A.; Lipman, N. H.; Rugge, H. R.; Vik, O. T. (Univ. of California, Berkeley). Phys. Rev., D; 2: 1199-1204(1 Oct 1970).

The measurement of the polarization in the reaction $\pi^- + p \rightarrow \pi^0 + n$ at an incident-pion kinetic energy (lab) of 310 MeV and at an angle of 30° in the c.m. system is reported. The polarization was obtained from measurements of the left-right asymmetry in the scattering of the neutrons from liquid helium at lab-scattering angles of 75° and 125°. The measured polarization is 0.24 ± 0.07. (auth)

49329 REACTIONS $K^-n \rightarrow K^{*-}n$ AND $K^-n \rightarrow \bar{K}^0N^{*-}$ AT 3 GeV/c. Bakker, G. (Zeeman-Laboratorium, Amsterdam); Hoogland, W.; Tenner, A. G.; (and others). Nucl. Phys.; B16: 53-60(1970).

The production and decay characteristics of the $K^*(895)$ and $N^*(1236)$ are studied in the reactions: $K^-n \rightarrow K^{*-}n$ and $K^-n \rightarrow \bar{K}^0N^{*-}$. The results are compared with the predictions of the absorption model. (auth)

49330 DOUBLE-REGGE-POLE MODEL ANALYSIS OF $\pi^-p \rightarrow \pi^-\pi^-\Delta^{++}$ AT 6 GeV/c. Mott, J. E.; Martin, H. J.; Galloway, K. F. (Indiana Univ., Bloomington). Nucl. Phys.; B16: 102-8(1970).

Experimental distributions for all momentum transfers, two-body masses and decay angles in the $\pi^-\pi^-\Delta^{++}$ final state were obtained and analyzed with two models: diffraction production combined with one-pion exchange and double-Regge-trajectory exchange. The double-Regge-pole model yields a good descrip-

tion of the data even when all allowed values of final state two body masses are used, an approach justified by duality. (auth)

49331 QUASI-TWO-BODY PRODUCTION IN $K^-n \to \Sigma + +$ MESONS AT 4.94 GeV/c. DiBianca, F. A.; Einschlag, M. B.; Endorf, R. J.; Engler, A.; Fisk, H. E.; Kraemer, R. W.; Yekutieli, G. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Phys.; B16: 69-76(1970).

Data on the following quasi-two-body reactions produced in K^-n interactions at 4.94 GeV/c are presented: $\Sigma^-\pi^0$, $\Sigma^-\eta^0$, $\Sigma^-\rho^0$, $\Sigma^-\omega^0$, $\Sigma^-\eta'^0$, $\Sigma^-\phi^0$, Σ^-f^0, $\Sigma^-f'^0$, $\Lambda(1405)\pi^-$ and $\Lambda(1520)\pi^-$. Cross sections, four-momentum transfer distributions, and density matrix elements are discussed. Assessment of possible exchange mechanisms and comparisons with the predictions of the quark model are made. (auth)

49332 PRODUCTION OF $K^*(892)$ IN K^+N INTERACTIONS AT 3 GeV/c. Bassompierre, G. (CERN, Geneva); Goldschmidt-Clermont, Y.; Grant, A.; (and others). Nucl. Phys.; B16: 125-54(1970).

The reactions $K^+d \to K^+\pi^-pp$, $K^+d \to K^0\pi^0pp$, and $K^+d \to K^0\pi^+pn$ were studied from an exposure of the Saclay 81-cm bubble chamber filled with deuterium and exposed at CERN to a separated 3 GeV/c K^+ beam. In reactions $K^+\pi^-pp$ and $K^0\pi^0pp$ there is abundant production of $K^{*0}(892)$ and some production of $K^*(1420)$. From the density matrix elements, it is found that $K^{*0}(892)$ is produced mainly by pion exchange. The $K^*(892)$ four-momentum-transfer distribution in $K^+\pi^-pp$ agrees with the predictions of the OPE model, as modified by Dürr and Pilkuhn. A marked asymmetry of the decay distribution of the $K^+\pi^-$ system is observed and discussed in the framework of a unitarized Veneziano model. In the $K^0\pi^+pn$ state, on the other hand, the production of $K^{*+}(892)$ and $N^{*++}(1236)$ is found to proceed mainly by vector exchange. (auth)

49333 DECAY-PROPERTIES OF THE $A_2(1300)$-MESON. Boeckmann, K. (Univ., Bonn); Rost, M.; Wagini, B.; (and others). Nucl. Phys.; B16: 221-38(1970).

The decay properties of the A_2-meson are studied in the reactions $\pi^+p \to pA_2^+$ and $\pi^+p \to \Delta^{++}A_2^0$ at 5 GeV/c. Branching ratios into $\rho\pi$, $\eta\pi$, $K\bar{K}$ and $X\pi$ are given. A J^P Dalitz-plot analysis of the total A_2^0 peak confirms the 2^+ assignment. A double peak analysis excludes 1^- as a pure state in either half and favors 2^+ in both. (auth)

49334 SEARCH FOR $\Sigma(1616)$ IN K^-d INTERACTIONS AT 3 GeV/c. Barloutaud, R. (CEN, Saclay, France); Merrill, D. W.; Scheuer, J. C.; (and others). Nucl. Phys.; B16: 201-8(1970).

No evidence was found for the production of $\Sigma(1616)$ in the reaction $K^-n \to \Sigma(1616)\pi^+\pi^-$ ($\Sigma(1616) \to \Lambda\pi^+$) at 3 GeV/c. The reaction $K^-n \to \Sigma^-(1660)\pi^+\pi^-$ ($\Sigma^-(1660) \to \Sigma^0\pi^-$) occurring at this incident momentum appears to be responsible for the small enhancement seen in the $\Lambda\pi^-$ mass distribution around 1620 MeV. (auth)

49335 FIVE AND SIX CHARGED-PARTICLE FINAL STATES FROM π^+ BEAMS WITH MOMENTA OF 2.7 GeV/c AND 3.7 GeV/c INTERACTING WITH DEUTERIUM. Campbell, John Henry. Lafayette, Ind.; Purdue Univ. (1969). 113p. University Microfilms Order No. 70-8868.

Thesis.

A study of the five and six charged particle final states from the interaction of 2.7 GeV/c and 3.7 GeV/c π^+ beams with deuterium was made. The data were obtained from a film exposure of the 72" deuterium bubble chamber at the Lawrence Radiation Laboratory. Production of the η' (958) and the D^* (1285) meson resonances is observed. The D^* meson is seen to decay to the δ^+(962) meson, and the δ^+ is further observed to decay into $\pi^+\eta$. The characteristics of these mesons are studied. Copious production of the η, ω^*, and ρ^* meson resonances, as well as the Δ^{++} (1236) nucleon resonance is seen. Cross sections for resonance production are determined. (Diss. Abstr.)

49336 EVIDENCE FOR PION EXCHANGE IN $K^-p \to K^*\pi N$ AT 3 GeV/c. Colton, Eugene (Univ. of California, Los Angeles); Prum, Samuel; Schlein, Peter E.; Verglas, Alain J. Nucl. Phys.; B17: 117-36(1970).

Peripheral $K^*(891)$ production is observed in states leading to $K^-p \to K^0\pi^-\pi^+p$, $K^-p \to K^0\pi^-\pi^+n$, and $K^-p \to K^-\pi^+\pi^-p$ at 3 GeV/c. The data for $K^-p \to K^*(891)\pi N$ are consistent with the absolute predictions of one-pion exchange with off-mass-shell $K\pi$ and πN scattering at the two vertices. However, $I = 0$ exchange, when allowed, appears to dominate for πN masses greater than 1.4 GeV. (auth)

49337 SCATTERING OF NEGATIVE PIONS ON CARBON. Binon, F.; Duteil, P.; Garron, J. P.; Gorres, J.; Hugon, L.; Peigneux, J. P.; Schmit, C.; Spighel, M.; Stroot, J. P. (CERN, Geneva). Nucl. Phys.; B17: 168-88(1970).

Data are presented on elastic and inelastic differential cross sections as well as on total cross sections for negative pions on carbon in the energy range 120 MeV to 280 MeV. (auth)

49338 K^+n CHARGE EXCHANGE AT 12 GeV/c. Firestone, A.; Goldhaber, G.; Hirata, A.; Lissauer, D.; Trilling, G. H. (Univ. of California, Berkeley). Phys. Rev. Lett.; 25: 958-62 (5 Oct 1970).

The differential cross section for the reaction $K^+n \to K^0p$ at 12 GeV/c was measured. It was found that the forward amplitude is essentially real, the differential cross section equals that for the reaction $K^-p \to K^0n$, and the differential cross section agrees well with the predictions of the Regge-pole model of Rarita and Schwarzschild. Also data were compiled on the cross section for the K^+n charge-exchange reaction as a function of incident momentum, and it was compared with that for $K^+p \to K^0\Delta^{++}$. It is found that beyond threshold effects these two reactions have the same cross section. (auth)

49339 PRODUCTION AND DECAY OF THE anti $K^{*0}(890)$ AND $N^{*-}(1236)$ RESONANCES IN K^-d COLLISIONS AT 3.0 GeV/c. Haber, B. (Weizmann Inst. of Science, Rehovot, Israel); Shapira, A.; Alexander, G.; (and others). Nucl. Phys.; B17: 289-316(1970).

In a K^-d experiment at 3 GeV/c the final state $K^-n\,\pi^+\pi^-(p_s)$ was investigated. It is found that the quasi-two-body reaction $K^-n \to K^*N^*$ has a cross section of (0.93 ± 0.07) mb and accounts for about 53% of the final state. Production and decay angular distributions for both resonances, as well as single and joint spin density matrix elements have been studied. The results are compared with the absorption model predictions, under the assumption of pion exchange and also with various quark model predictions. (auth)

49340 SINGLE PION PRODUCTION IN π^+p INTERACTIONS BETWEEN 0.6 AND 0.8 GeV/c. Bowler, M. G.; Cashmore, R. J. (Oxford Univ.). Nucl. Phys.; B17: 331-58(1970).

A partial wave analysis of single pion production in π^+p interactions at five momenta between 0.6 and 0.8 GeV/c is discussed. Inelasticity parameters are obtained at four momenta which differ in some details from those extracted from a CERN elastic phase shift analysis. It is found that this CERN phase shift analysis systematically overestimates inelasticity in our momentum range, and deduces that absorption from the important S_{31} incident wave is dominated by ρ-meson production rather than by $N^*(1236)$ production. (auth)

49341 POSITIVE PION-PROTON ELASTIC SCATTERING AT 895, 945, 995, AND 1040 MeV/c. Baker, S. L. (Imperial Coll. of Science and Tech., London); Dornan, P. J.; Gopal, G. P.; Webster, G. J.; Bull, V. A.; March, P. V.; Tayler, V.; Townsend, D. W. Nucl. Phys.; B18: 29-44(1970).

The differential cross section for π^+p elastic scattering at 895, 945, 995, and 1040 MeV/c was measured in a hydrogen bubble chamber. The results are in good agreement with previous measurements using counter techniques except at extreme backward angles where significantly lower cross sections are obtained. (auth)

49342 $K\pi$ SYSTEM IN THE CHANNEL $K^+\pi^-\Delta^{++}$ AT 9 GeV/c. Fu, C.; Firestone, A.; Goldhaber, G.; Trilling, G. H. (Univ. of California, Berkeley). Nucl. Phys.; B18: 93-111(1970).

The study of the $K\pi$ system in the channel $K^+\pi^-\Delta^{++}$ is complicated by the presence of the broad low-mass $\Delta^{++}\pi^-$ enhancement centered near 1580 MeV. A cut which removes this effect reveals a break in the t' distribution at $|t'| \approx 0.05$ (GeV/c)^2, with a very steep forward peak of slope $a = 23.6 \pm 5.2$ (GeV/c)$^{-2}$ for $|t'| < 0.05$ (GeV/c)^2 and a slope of $a = 9.5 \pm 2.0$ (GeV/c)^2 for $|t'| \geq 0.05$ (GeV/c)^2. This forward peak is associated with a single-pion-exchange mechanism. A small enhancement at $M(K^+\pi^-) \approx 1100$ MeV is observed in a t' region dominated by non-pion-exchange mechanisms. (auth)

49343 ENERGY DEPENDENCE OF THE 3π EFFECTIVE MASS SPECTRUM IN THE REACTION $\pi^-p \to p\pi^+\pi^-\pi^-$. Paler, K. (CERN, Geneva). Nucl. Phys.; B18: 211-14(1970).

For the reaction $\pi^-p \to p\pi^+\pi^-\pi^-$ at incident lab momenta from 2.7 to 20 GeV/c, the variation of the cross section of various intervals of the $\pi^+\pi^-\pi^-$ effective mass distribution with the incident lab momentum of the π^- is presented. An essentially energy-independent cross section for the production of $\pi^+\pi^-\pi^-$ effective masses less than 1.4 GeV, i.e., the "A" meson region, is observed for incident lab momenta greater than 8 GeV/c. (auth)

49344 EVIDENCE FOR A $K\pi\pi$ ENHANCEMENT IN π p INTERACTIONS AT 7 GeV/c. Hsieh, Jen-shu; Munir, B. A.; Bishop,

J. M.; Huwe, D. O. (Ohio Univ., Athens). Nucl. Phys., B18: 17-23(1970).

Strange particle production in π^-p interactions at 7 GeV/c was studied. The analysis on two of the six body final states studied, e.g., $\pi^-p \to AK\pi\pi\pi$ and $\pi^-p \to NK\bar{K}\pi\pi\pi$, is reported. There is evidence for an enhancement in the $K\pi\pi$ system at 1256 ± 8 MeV with Γ = 45 MeV, which cannot be attributed to any kinematic effects. This enhancement has a value of $T_3 = 1/2$ and a strangeness $S = \pm 1$. It seems to be produced in the forward direction. (auth)

49345 POSSIBLE INTERPRETATIONS OF THE pω MASS ENHANCEMENT NEAR THRESHOLD, IN $\pi^-p \to \pi^-p\omega$ AT 7 GeV/c. Milgram, M. S. (Univ. of Toronto); Chao, A.; Johnston, T. F.; Prentice, J. D.; Streenberg, N. R.; Yoon, T. S.; Morse, R.; Oh, B. Y.; Walker, W. D. Nucl. Phys.; B18: 1-16(1970).

An analysis is given of the threshold signal in the pω invariant mass of the one constraint reaction $\pi^-p \to \pi^-p\omega$ at 7 GeV/c. It is found that the experimental data favor interpretation of this effect as a resonance of mass ≈ 1750 MeV and width ≈ 110 MeV. Diffraction dissociation mechanisms are investigated and preliminary results of a multi-Regge calculation are cited. The latter models do not fit the data well; however, they cannot be ruled out, and in fact the decay of a diffractively produced virtual N*(1470) gives a reasonably good fit. Comparisons are made with data for 3 GeV/c pions incident on protons as well as the pω spectrum of $K^-p \to K^-p\omega$ and $K^+p \to K^+p\omega$. It thus appears that the effect is not due to a statistical fluctuation. (auth)

49346 REACTION $\pi^-p \to p\pi^+\pi^-\pi^-$ AT 13 AND 20 GeV/c. Brandenburg, G. W.; Brenner, A. E.; Ioffredo, M. L.; (and others) (Harvard Univ., Cambridge, Mass.). Nucl. Phys.; B16: 287-320 (1970).

Data from the reaction $\pi^-p \to p\pi^+\pi^-\pi^-$ at 13 and 20 GeV/c are analyzed and compared with the predictions of the Wolf calculation of the one-pion-exchange model (OPEM). Strong production of the $N^{*++}(1236)$ isobar and ρ^0 meson as well as some f^0 meson production is observed. In the $p\pi^-$ system, there is evidence of the $N^{*0}(1236)$ and the $N^{*0}(1688)$ isobars and indications of $N^{*0}(1518)$ and Roper resonance production. The $p\pi^+\pi^-$ system also exhibits enhancements in the vicinity of 1.5 and 1.7 GeV. There is a strong, unstructured A-enhancement in the 3π mass spectrum which decays preferentially through the πρ channel. A prominent peak in the region of the π(1640) is also seen in this spectrum. The OPEM is able to reproduce many of the salient features of the data with the notable exception of the 3π enhancements in the A and π(1640) regions. (auth)

49347 MEASUREMENT OF THE POLARIZATION PARAMETER IN THE REACTIONS $\pi^-p \to \pi^0n$ AND $\pi^-p \to \eta n$ AT 5.9 AND 11.2 GeV/c. Bonamy, P. (CEN, Saclay, France); Borgeaud, P.; Brehin, S.; (and others). Nucl. Phys.; B16: 335-63(1970).

Final results are reported on the measurement of the polarization parameter Po(t) in the charge exchange reaction $\pi^-p \to \pi^0n$ at 5.9 GeV/c for $0.017 \leq -t \leq 0.25$ $(GeV/c)^2$ and at 11.2 GeV/c for $0.017 \leq -t \leq 0.35$ $(GeV/c)^2$. Partial results of this experiment have been reported previously. Po(t) was also measured in the reaction $\pi^-p \to \eta n$ for $0.02 \leq -t \leq 0.14$ at 5.9 and for $0.02 \leq -t \leq 0.28$ at 11.2 GeV/c. The experiment, performed at the CERN PS, was motivated by the interpretation of the results on the differential cross sections for these reactions in terms of the exchange of a single Regge pole. A necessary consequence of such a model is the equality of the phases for the non-spin flip and the spin flip parts of the amplitude. This implies a zero value for Po(t) at all t values. Averaged over our region of acceptance Po = (16.0 ± 2.1) × 10^{-2} at 5.9 GeV/c and Po = (11.4 ± 1.8) × 10^{-2} at 11.2 GeV/c for charge-exchange was found, in clear contradiction with the above prediction. For η production Po = (19 ± 12) × 10^{-2} at 5.9 GeV/c and Po = (10 ± 7) × 10^{-2} at 11.2 GeV/c. The description of the experiment and the method of analysis used are treated in detail. (auth)

49348 MASS OF THE POSITIVE PION. Booth, P. S. L.; Johnson, R. G.; Williams, E. G. H.; Wormald, J. R. (Univ. of Liverpool). Phys. Lett.; 32B: 723-4(14 Sep 1970).

An improved value of the mass of the positive pion is reported, the result being $m_{\pi^+} = 139.584 \pm 0.025$ MeV/c^2. When compared with the mass of the negative pion this result may be regarded as a verification of the calculations relating m_{π^-} to the measured 4f – 3d transition energies in pionic calcium and titanium. Alternatively, the ratio of the two masses may be regarded as a check of CPT invariance. (auth)

49349 BACKWARD ELASTIC SCATTERING FROM 875 TO 1580 MeV/c. Abillon, J. M.; Borg, A.; Crozon, M.; Leray, T.; Mendiburu, J. P.; Tocqueville, J. (College de France, Paris). Phys. Lett.; 32B: 712-15(14 Sep 1970).

The differential cross sections for π^-p elastic scattering were measured near 180°, in the momentum range 875-1580 MeV/c. The results are compared with recent phase shift analysis, showing some notable discrepancies. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 49970.

49350 (IC-70/7) NON-POLYNOMIAL LAGRANGIAN THEORIES. Salam, Abdus (International Centre for Theoretical Physics, Trieste (Italy)). Feb 1970. 30p. Dep. CFSTI (U. S. Sales Only).

Methods are developed to extract numbers from nonpolynomial Lagrangian theories for particle physics. Such methods must ensure the resolution of the difficulties of nonrenormalizable theories. These difficulties are an infinite number of distinct infinity types and a high-energy behavior which violates Froissart-like bounds. An exposé of the methods, higher orders, and supergraphs are discussed. (J.F.P.)

49351 (IFPTH-5/70) OPERATORIAL EXPANSION OF THE PRODUCT OF TWO CURRENTS. Bonora, L.; Vendramin, I. (Padua Univ. (Italy). Istituto di Fisica). [1970]. 14p. Dep. CFSTI (U. S. Sales Only).

On the grounds of general principles and a certain set of hypotheses the most general expansion of the product of two U(3) × U(3) currents in neighboring space-time points is built up following the Wilson method. By means of this expansion a certain number of current-current and current-derivative of current equal-time commutators are determined. These are in agreement with the results obtained by other methods. As an application, it is shown that the structure of stress-energy tensor suggested by Sugawara can be embodied as a limiting case in Wilson's theory. (auth)

49352 (IFPTH-6/70) CONSTRAINTS ON EQUAL TIME COMMUTATORS FROM LORENTZ COVARIANCE. Sartori, G. (Padua Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Padua (Italy)). [1970]. 8p. Dep. CFSTI (U. S. Sales Only).

Constraints on equal-time commutators are rederived by means only of group theoretical techniques implemented by the use of some formal properties E_n commutators. In order to avoid the formal difficulties connected with half-integer spins the constraints are proven only in the case of two tensor local operators. The results justify the extensive exploitation of these constraints made in previous work. (J.F.P.)

49353 (IFPTH-8/70) MULTI CLUSTER MODEL FOR VERY HIGH ENERGY COLLISIONS. Bassetto, A.; Paccanoni, F. (Padua Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Padua (Italy)). Jul 1970. 22p. Dep. CFSTI (U. S. Sales Only).

With a suitable choice of kinematical variables a multi-cluster model is studied for very high energy processes, improving the agreement of the theoretical predictions with experimental multiplicities of secondaries and mean transverse momenta. The consequences of this model on the forward absorptive part of the elastic amplitude are examined in the energy regions where diffraction dissociation dominates. An example is given where a consistency condition determines the character of the leading singularity responsible for the high energy behavior of the total cross section. (auth)

49354 (NP-18410) RECENT DEVELOPMENTS IN PARTICLE PHYSICS. Nobel Lecture, December 11, 1968. Preprint Les Prix Nobel. Alvarez, Luis W. (California Univ., Berkeley. Lawrence Radiation Lab.). 1969. 45p. Kungl. Boktryckeriet P.A. Norstedt and Soner, Stockholm Sw. Kr. $4.00.

The developments in particle physics are reviewed. Bubble chambers, data-analysis programs, and the utilization of computers at the Lawrence Radiation Laboratory are described. The use of the equipment for discovery of strange particles and strange particle resonances is presented. 77 refs. (Sweden)

49355 ASYMPTOTIC BEHAVIOR OF THE KLEIN-GORDON EQUATION WITH EXTERNAL POTENTIAL. Chadam, John M. (Cornell Univ., Ithaca, N. Y. Indiana Univ., Bloomington). J. Math. Anal. Appl.; 31: 334-48(Aug 1970).

Let $U_s(t)$ and $U(t)$ denote the temporal propagator of the Klein-

Gordon equation $\Box\phi = m^2\phi$ and the perturbed equation $\Box\phi = (m^2 + V(x))\phi$, respectively. It $V \in L^p(E^3)$ for any $2 \leq p \leq 3$, V is real-valued and satisfies a restriction on the size of its negative part, then the (free-to-physical) wave operators, $W_\pm = s - \lim U(-t)\, U_0(t)$, as $t \to \pm\infty$ exist as bounded operators on the finite-energy and Lorentz-invariant solution space of the Klein–Gordon equation. (auth)

49356 INLEDANDE ELEMENTARPARTIKELFYSIK. (Introductory Elementary Particle Physics. Second Edition). Kivikas, Toeivelemb. Lund, Sweden; Studentlitteratur (1970). 66p.

A general survey of elementary particle physics is given as a compendium for lectures in physics at Lund University. (FHS) (SW)

49357 SHORT-WAVE REPULSION IN LOW-ENERGY INTERACTIONS. Shirkov, D. V. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 278-82 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

This is a review of recent results obtained in the framework of a semiphenomenological theory of low-energy hadron interactions. The theory is based on the dispersion relation technique and accounts for high energy effects in the form of effective short-range repulsion potentials. The simple space picture of hadrons corresponding to the main features of scattering at low and intermediate energy is also given. (auth)

49358 REGGEIZED DIFFERENTIAL CROSS SECTIONS IN A COVARIANT FORMALISM. Gault, F. D. (Univ. of Durham, Eng.); Scadron, M. D. Nucl. Phys.; B15: 443-50(1970).

A scheme is developed for calculating Reggeized spin-averaged differential cross section directly from the Regge vertices and the results are tabulated. Photonic vertex couplings for boson exchange are also derived. (auth)

49359 RELATION OF THE VENEZIANO AMPLITUDE TO STRUCTURED PARTICLE. Hara, Osamu (Nihon Univ., Tokyo). Soryushiron Kenkyu; 40: D59-61(Dec 1969). (In Japanese).

If the Veneziano amplitude can be factorized, it can be treated on the field theoretical lines. Nambu et al. have proposed the Hamiltonian for propagator which includes a set of the infinite number of simple harmonic oscillators; $H = \sum_{n=1}^{\infty} n\alpha_\mu^+ \alpha_\mu^-$ (μ indicates the vector component in the Lorentz space). This Hamiltonian is similar to that of a deformable sphere model, so that the Veneziano amplitude may be regarded as the exchange of "the structured particle." The eigen oscillation in this model is decided by the boundary condition that the stress tensor comes to zero on the surface of the deformable sphere. When the value is not zero, energy goes in and out through the surface, and then this value corresponds to the coupling constant which determines the intensity of interaction, so that the vertex may be decided. From this point of view, the Veneziano amplitude is the above interaction handled by the Born approximation, and seems to correspond with the Feynman diagram for the structured particle. (Japan)

49360 EXISTENCE OF EXOTIC RESONANCE AND THE VENEZIANO MODEL. Kawarabayashi, Ken (Kyoto Univ.). Soryushiron Kenkyu; 40: 39-43(Dec 1969). (In Japanese).

An attempt is proposed for the analysis of the scattering of hadrons. The assumption that the exotic resonance is not existent, one of the assumptions usually introduced in the analysis of the scattering amplitude of hadrons under the finite energy sum rule, is dropped, and instead of it, the revised selection rule is adopted, in which arbitrary two hadron-pairs necessarily hold one or more quark lines in common at the vertex with three external hadron lines. Then the problem of "the difficulty in baryon-antibaryon scattering" is solved, and it is shown that the exotic resonance required for the FESR solution totals 81-plet. The quark model for hadrons must be modified to include baryon-antibaryon pair excitation, and it may account for the level structure of hadrons. The mass formula including the exotic resonance is given in a simple form. (Japan)

49361 COMPOSITE PARTICLE MODEL AND CHIRAL SYMMETRY. Masukawa, Toshihide (Nagoya Univ., Japan). Soryushiron Kenkyu; 40: D44-9(Dec 1969). (In Japanese).

In terms of chiral symmetry, a pion can be regarded as a Goldstone boson which appears as a result of spontaneous breakdown of chiral symmetry. A discussion was given on the question of how this situation is reflected in the composite particle model in which a pion is not essentially different from other mesons. First, introduction of chiral symmetry into the composite particle model was discussed. It was shown that there exists a nonlinear realization of chiral symmetry group other than and independent of the known linear transformation of urbaryon. The conditions to be satisfied for this to happen were given. In quark model and three-triplet model there is no independent realization of chiral symmetry other than the linear transformation using γ_5-matrix. The Lagrangian which describes the dynamical system contains a large chiral symmetric part and a small symmetry breaking part. When the interaction is strong enough to cause spontaneous breakdown, the solution can be approximated by the solution of spontaneous breakdown in the absence of symmetry breaking part. This allows a pion to be regarded as a Goldstone boson. (Japan)

49362 EXTENSION, INTERNAL DEGREE OF FREEDOM AND MODELS, OF ELEMENTARY PARTICLES. Goto, Tetsuo (Nihon Univ., Tokyo). Soryushiron Kenkyu; 40: D52-8(Dec 1969). (In Japanese).

In the nonrelativistic case, a particle with structure can be given a natural formulation according to the intuitive picture, although the treatment for different intuitive pictures can be made quite similar as exemplified by the rigid body model and the nonrelativistic quark model. Both can be represented by the eigenfunctions of an oscillator, spinor for the former and vector for the latter. In relativistic case, the situation is quite different. The intuitive picture, either of extended particle model or of bound state model, does not give unique relativistically covariant formulation, so that an abstract dynamical system is better as a phenomenological model than an intuitive picture. The infinite component wave equation was discussed in this connection. A few formulas were given on the Majorana representation, which may become useful in actual treatment. (Japan)

49363 SITUATION AND REVIEW OF THE THEORY OF ELEMENTARY PARTICLES: ON THE HADRON DYNAMICS. Kawarabayashi, Ken (Kyoto Univ.). Soryushiron Kenkyu; 40: 152-67(Dec 1969). (In Japanese).

The progress in the hadron dynamics for the last year is reviewed. Many types of interaction, which give qualitatively different transition probability, exist together in the hadron. This fact resulted from the data of the width of spectra. These interactions are first order perturbation, except one strong interaction ($g^2 \sim 1$). Group theoretical approach is applied for the strong interaction, since the calculation based on perturbation is no more applicable. Hadron dynamics is for determining the interval and width of spectra simultaneously. The character of hadron appears through the scattering amplitude which depends upon three variables. Two of them are treated by the analytic S matrix and the other is handled by the symmetry theory. In the symmetry theory, the principal problem is a mass formula of hadron, and the approach by SU(3) symmetry based on the quark model is successful. The analytic S matrix theory has developed from the Regge pole theory, through the finite energy sum rule, to the Veneziano model, and it becomes possible to handle interval variables. The Veneziano model which is consistent with the duality is the characteristic result of the hadron dynamics. (Japan)

49364 COMPILATION OF COUPLING CONSTANTS AND LOW-ENERGY PARAMETERS. Ebel, G.; Pilkuhn, H.; Steiner, F. (Univ., Karlsruhe, Ger.). Nucl. Phys.; B17: 1-26(1970).

Coupling constants and various low-energy parameters for elementary-particle reactions collected from recent publications are presented. The aim is to give a survey and to facilitate access to the original work in this field. (auth)

49365 STUDY OF THE APPROXIMATE LAGRANGIANS OF AN ISOLATED TWO BODY SYSTEM FROM ITS RELATIVISTIC INVARIANCE. Mas, Luis (Paris Univ.). Compt. Rend., Ser. A; 271: 206-8(20 Jul 1970). (In French).

From the definition of relativistic invariance given previously a form of the approximate Lagrangians compatible with this invariance was sought, which would be valid up to $(v/c)^2$ terms, for an isolated two body system. The total energy–momentum, the total angular momentum, and the center of mass were determined to the same degree of accuracy. (France)

49366 M-LOOP GENERALIZED VENEZIANO FORMULA. Lovelace, C. (CERN, Geneva). Phys. Lett.; 32B: 703-6(14 Sep 1970).

The Veneziano formula with M closed loops is constructed both by Nielsen's representation and by sewing reggeons. The logarithm of its integrand is just the third Abelian integral of a sphere with M handles. Domain variational theory determines all its Regge singularities. (auth)

Electromagnetic

Refer also to abstracts 49493 and 49567.

49367 (LNF-70/21) e^+e^- ANNIHILATION INTO HADRONS. Note No. 447. Ferrara, S.; Greco, M.; Grillo, A. F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 22 May 1970. 4p. Dep. CFSTI (U. S. Sales Only).

Some predictions on $e^+ + e^-$ annihilation into hadrons are presented. These predictions are based on a statistical model for the inelastic e + p scattering and the parton theory of electromagnetic interactions of hadrons. (J.F.P.)

49368 (NYO-4076-8) POSSIBLE TESTS FOR THE PRESENCE OF AN ISOTENSOR CURRENT. Domokos, G.; Suranyi, P. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). 18 Jun 1970. 10p. Dep. CFSTI.

Sensitive tests are proposed to determine whether the electromagnetic current has an isotensor component. These tests are double pion photoproduction and electron–positron annihilation into $\pi^+\pi^-\pi^0$. (J.F.P.)

49369 (NYO-4076-9) OVERLAPPING RESONANCE MODEL OF DEEP INELASTIC ELECTRON SCATTERING. Domokos, G.; Kovesi-Domokos, S. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). 30 Jun 1970. 17p. Dep. CFSTI.

It is suggested that deep inelastic electron scattering can be understood in terms of overlapping resonance contributions to the amplitude of virtual forward Compton scattering. The resonance contributions are calculated with the help of a semiempirical model of the hadron spectrum, under the assumption that the virtual resonance photoproduction matrix elements are universal functions of the photon energy divided by the resonance mass squared. An asymptotic expression for the structure function W_2 is derived and compared with experimental data. The prediction of the model agrees well with the experimental results. (auth)

49370 (NYO-4204-2) SPECTRAL FUNCTIONS FROM ELECTRON POSITRON ANNIHILATION. Pais, A. (Rockefeller Univ., New York); Treiman, S. B. (Princeton Univ., N. J. Joseph Henry Labs.). [1970]. Contracts AT(30-1)-4204; AF49(638)-1545. 10p. Dep. CFSTI.

It is shown, on the basis of PCAC and current algebra notions, how spectral function information on the weak axial vector current and isovector electromagnetic current can be extracted from soft pion production in e^+–e^- annihilations. (auth)

49371 (RLO-2041-42) EFFECT OF $\epsilon(J^P = 0^+, I = 0)$ RESONANCE ON $e^+e^- \to \pi^+\pi^-\gamma$. Sarker, A. Q. (Oregon Univ., Eugene). [1970]. 10p. Dep. CFSTI.

The product of the coupling constants, $\epsilon \to \pi\pi$ and $\epsilon \to 2\gamma$ is estimated from a superconvergent sum rule obtained from the helicity flip amplitude of pion-Compton scattering. It is then used to show that the contribution of ϵ(even-C) to the process, $e^+e^- \to \pi^+\pi^-\gamma$ (to order α^3) is about two orders larger than that when the pions are in odd-C states. (auth)

49372 (SINP-TH-69-8) PHOTOPRODUCTION SUM RULES: A TEST FOR PURE AND ABSORPTIVE REGGE MODELS. Roy, D. P. (Saha Inst. of Nuclear Physics, Calcutta (India)). [18 Aug 1969]. 10p. Dep. CFSTI (U. S. Sales Only).

Contrary to a previous assertion it is shown that a suitable choice of pion photoproduction sum rules makes a clear distinction between pure and absorptive pion pole exchanges and strongly disagrees with the latter on the basis of existing experimental data. (auth)

49373 (UJV-2439-F) INTERNAL BREMSSTRAHLUNG IN PION-CHARGE-EXCHANGE REACTION AND THE REACTION MECHANISM. Janouch, F.; Mach, R. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 6p.

The threshold singularities of internal bremsstrahlung spectrum in the pion-charge-exchange reaction are used for the identification of the reaction mechanism. (auth)

49374 DETERMINATION OF $\rho\pi\gamma$ COUPLING CONSTANT FROM ρ^0 PHOTOPRODUCTION. Kawaguchi, Masaaki; Yokomi, Hiroyuki (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 43: 1113-15(Apr 1970).

The technique of extrapolating the differential cross section in the unphysical region to $t = m_\pi^2$ is applied to the pion exchange contribution to ρ^0 photoproduction from the proton, in order to determine the $\rho\pi\gamma$ coupling constant. (L.B.S.)

49375 PHOTOPRODUCTION PROCESSES IN THE QUARK MODEL. Sastry, C. V.; Misra, S. P. (Regional Engineering Coll., Rourkela, India). Phys. Rev., D; 2: 1317-19(1 Oct 1970).

Many sum rules for photoproduction processes are derived starting from the vector-dominance hypothesis and treating the mesons consistently as quark-antiquark composites. (auth)

49376 PAIR PRODUCTION IN VACUUM BY AN ALTERNATING FIELD. Brezin, E.; Itzykson, C. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Rev., D; 2: 1191-9(1 Oct 1970).

The creation of pairs of charged particles in an alternating electric field is discussed. The dependence on the frequency is computed and found negligible. A formula is obtained for the field intensities required in order to observe the effect $E \gtrsim m\omega_0 c/e \sinh(\hbar\omega_0/4mc^2)$. (auth)

49377 PRODUCTION OF NEUTRAL VECTOR MESONS IN PROCESSES $e^- + e^+ \to \rho^0(\omega^0, \phi^0) + \gamma$. Choban, E. A. (Leningrad Polytechnic Inst.). JETP Lett. (USSR) (Engl. Transl.); 11: 346-8 (20 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 505-8 (20 May 1970).

The production of real vector mesons in the process $e^- + e^+ \to \rho^0(\omega^0, \phi^0) + \gamma$ is considered. The energy region is treated in which $s - m_V \gtrsim m_V$, where m_V is the mass of the vector meson, $s = 4E^2$, E is the energy of the initial particle in the cms of the electron and positron. The cross sections and polarization parameters of the vector mesons are discussed. (J.F.P.)

49378 POLARIZATION THEOREMS IN PION PHOTOPRODUCTION. Ravndal, F. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., D; 2: 1278-80(1 Oct 1970).

Stichel's theorem relating the state of linearly polarized photons and spin-parity of t-channel exchanges in pion photoproduction is reexamined and generalized. For two specific initial and final nucleon polarization configurations, an exact theorem valid for all photon energies is proved. (auth)

49379 PROTON COMPTON SCATTERING AND PHOTOPRODUCTION OF VECTOR MESONS. Okada, Kunihiko (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 43: 1574-83(Jun 1970).

Proton Compton scattering and photoproduction of vector mesons at high energies are studied in terms of the quark model. It is shown that under the vector meson dominance hypothesis the quark model gives the γp total hadronic cross section in good agreement with the experimental data. The real-to-imaginary ratio of forward proton Compton scattering is related to the total cross sections and the real-to-imaginary ratios of amplitudes for meson–proton scattering. The differential cross section for photoproduction of vector mesons at zero momentum transfer is calculated without neglecting the contribution of the real part of the amplitude. A comment on Harari's conjecture is also given in connection with photoproduction of φ meson. (auth)

49380 PRODUCTION OF TWO ELECTRON–POSITRON PAIRS IN COLLISIONS OF FAST PARTICLES. Serbo, V. G. (Novosibirsk State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.); 12: 39-40(5 Jul 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 50-2 (5 Jul 1970).

The study of the production of two electron–positron pairs in the collision of fast particles covers photon reactions with nuclei and electron–positron crossed beam collisions. It is noted that the cross section for the production of two muon pairs is suppressed compared with the production of two electron pairs. At the same time the cross section for the production of one electron pair and one muon pair can be higher by two orders of magnitude. (J.F.P.)

49381 PION PHOTOPRODUCTION TREATING NUCLEI AS ELEMENTARY PARTICLES. Pascual, P.; Sanchez-Gomez, J. L. (Univ., Valencia). Nucl. Phys.; B16: 191-200(1970).

A new formulation of pion photoproduction, when all intervening nuclei are treated as elementary particles, is presented. Using the covariant spin formalism, invariant form factors are introduced. The theory is applied to several cases. (auth)

49382 COULOMB DISINTEGRATION OF $^3_\Lambda$H IN NUCLEAR EMULSION. Bohm, G; Wysotzki, F. (Institut fuer Hochenergiephysik, Berlin). Nucl. Phys.; B15: 628-36(1970).

The decay of $^3_\Lambda$H caused by electromagnetic interaction with nuclei is studied. Its effect on measurements of the mean lifetime of $^3_\Lambda$H in nuclear emulsion is calculated. (auth)

49383 EFFECTS OF SU_3 VIOLATION ON BARYON ELECTROMAGNETIC PROPERTIES. Divakaran, P. P. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; B15: 601-16(1970).

An attempt is made to calculate the deviations of the baryonic electromagnetic form factors for small t from the Coleman–Glashow predictions by assuming that SU_3 is an asymptotically exact symmetry. This assumption leads to superconvergence

relations for linear combinations of form factors, which are then saturated by the ρ, ω and ϕ mesons. For the Dirac form factors a complete determination of the couplings of these mesons to all baryons is obtained. In the case of the Pauli form factors, estimates of the magnetic moments based on the mixing phenomenology give corrections to the SU_3 values which are quite large for Λ and Ξ^-. It is shown that the final results are quite stable with respect to large changes in the parameters deduced from mixing. For the two baryon moments measured so far, $\mu(\Lambda) = -0.64$ and $\mu(\Sigma^+) = 2.61$ proton magnetons are obtained. (auth)

49384 ANALYSIS OF VECTOR-MESON PRODUCTION BY POLARIZED PHOTONS. Schilling, K. (California Inst. of Tech., Pasadena); Seyboth, P.; Wolf, G. Nucl. Phys.; B15: 397-412(1970).

The formalism necessary to analyze production of vector mesons with polarized photons ($\gamma p \to pV$) is presented in detail. The decay angular distribution of the vector mesons is parameterized by the density matrices ρ^α, $\alpha = 0, 1, 2, 3$. Restrictions on the numerical values of the density matrix elements are derived. From the symmetry properties of the helicity amplitudes, it is shown that at high energies the combinations $\rho^0_{\lambda\lambda'}$, $\pi(-1)^\lambda \rho^1_{-\lambda\lambda'}$ to leading order in energy receive only contributions from natural (unnatural) parity exchange in the t-channel. It is shown that this is true in any coordinate system which can be reached from the vector-meson helicity system by a rotation around the normal to the production plane. The values of the density matrices as predicted by various models: elementary 0^+ exchange, spin independence, helicity conservation, are given. (auth)

49385 QUARK MODEL OF INTEGER CHARGES AND THE TWO γ DECAY OF π and η. Otokozawa, J. (Nihon Univ., Tokyo). Soryushiron Kenkyu; 40: D87-8(Dec 1969). (In Japanese).

It is hard to explain π^0 decay and η decay on the same standpoint. A trial which can explain both decays simultaneously is reported. With the Han-Nambu model, the following relation was established. $J_\mu^{(a,b)} = \frac{1}{2}\,\bar{q}\,\frac{1}{2}\,\lambda_a \times \frac{1}{2}\,\rho_b \gamma_\mu q$ where a and b represent unitary spin (a) and charm spin (b) respectively, and $\lambda_0 = (2/3)^{1/2}$. The symmetry of Gv, the definition of $J_{5\mu}$ (weak axial current) chosen so that the radiative correction of β decay does not diverge, and the reproducibility of the ordinary Adler-Weissberger for $f\pi$ were assumed. Inevitably, a vector meson becomes a charm singlet, and a 1^- meson becomes the mixed state of $3^{-1/2}(a,O) - (\frac{1}{2})^{1/2}(a,8)$ in the charm space, from these assumptions. At the same time, the presence of $\omega' = (0,8)$ is inevitable because of the consistency of commutation relation. The mass of ω' is assumed to be infinite. Then, all the variables can be determined by experiment. The solution of this calculation explains successfully the decay of π^0 to 2γ as well as the decay of η to 2γ, because the mass of ω' breaks the symmetry. (Japan)

49386 SCALE INVARIANCE AND CURRENT COMMUTATORS NEAR THE LIGHT CONE. Frishman, Y. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev. Lett.; 25: 966-9(5 Oct 1970).

Consequences of the assumption that current commutators have power-type singularities near the light cone are derived. An extension of Wilson's short-distance expansion of commutators is suggested for almost lightlike distances. Consequences for power-type singularities are derived for processes involving currents. Especially, generalized scaling laws are obtained for inelastic electron-nucleon scattering. The connection with Regge behavior is discussed. An application to electron-positron annihilation into hadrons is also made. (auth)

49387 PHASES IN VECTOR-MESON PHOTOPRODUCTION. Pumplin, Jon; Stodolsky, Leo (Stanford Univ., Calif.). Phys. Rev. Lett.; 25: 970-2(5 Oct 1970).

The phase of vector-meson photoproduction on nuclei is calculated using the optical model. The predicted relative phase between ρ^0 and ω^0 appears to disagree with experiment. (auth)

49388 DOMINANT COLLIDING-BEAM CROSS SECTIONS AT HIGH ENERGIES. Brodsky, Stanley J. (Cornell Univ., Ithaca, N. Y. Stanford Linear Accelerator Center, Calif.); Kinoshita, Toichiro; Terazawa, Hidezumi. Phys. Rev. Lett.; 25: 972-5(5 Oct 1970).

The calculation of the energy and angular dependence of the cross sections for the production of various particles by two-photon annihilation processes in e^+e^- and e^-e^- colliding beams is reported. For beam energy E of more than 1 GeV, these cross sections [$\sigma \propto \alpha^4(\ln E)^3$ become increasingly more important than the usual one-photon cross sections [$\sigma \propto \alpha^2(E)^{-2}$] for hadron production. (auth)

49389 SPECTRAL FUNCTIONS FROM ELECTRON-POSITRON ANNIHILATION. Pais, A. (Rockefeller Univ., New York); Treiman, S. B. Phys. Rev. Lett.; 25: 975-8(5 Oct 1970).

It is shown, on the basis of partial conservation of axial-vector current and current-algebra notions, how spectral-function information on the weak axial-vector current and isovector electromagnetic current can be extracted from soft-pion production in $e^+ - e^-$ annihilations. (auth)

49390 SCHWINGER EVEN INTEGER CHARGE QUANTIZATION CONDITION. Efinger, H. J. (Univ. of Georgia, Athens). Lett. Nuovo Cim.; 4: 277-80(15 Aug 1970).

A quantum-mechanical derivation of Schwinger's formula, allowing both odd and even integers, was previously pointed out. The formula $eg = (n + \frac{1}{2})\hbar c$ was obtained, where e and g denote electric and magnetic changes and $n = 0, 1, 2, \ldots$. It is shown that the extra $\frac{1}{2}$-term is quantum-mechanically correct due to the zero-point motion of the electric charge interacting with the applied magnetic field. It is also pointed out that the formula does not contradict Schwinger's formula $eg = n\hbar c$. (L.B.S.)

49391 POSSIBLE TESTS FOR THE PRESENCE OF AN ISOTENSOR CURRENT. Domokos, G.; Suranyi, P. (Johns Hopkins Univ., Baltimore). Lett. Nuovo Cim.; 4: 307-9(15 Aug 1970).

Double pion photoproduction and electron-positron annihilation into $\pi^+\pi^-\pi^0$ are suggested to test whether the electromagnetic current has an isotensor component. (L.B.S.)

49392 DOES A UNIFORMLY ACCELERATED CHARGE RADIATE? Luiz, A. M. (Univ., Pisa, Italy). Lett. Nuovo Cim.; 4: 313-15(15 Aug 1970).

The criteria for determining whether a uniformly accelerated charge radiates are examined. An attempt is made to show that a uniformly accelerated charge cannot radiate because the opposite assumption gives rise to contradictions with well-established facts such as action and reaction law and the principle of conservation of energy and momentum. (L.B.S.)

49393 π-CONSPIRACY AND FACTORIZATION IN VECTOR MESONS AND $\Delta(1236)$ ISOBAR PHOTOPRODUCTION. Ader, J. P.; Capdeville, M. (Laboratoire de Physique Theorique, Bordeaux). Nucl. Phys.; B17: 127-40(1970).

The most recent experimental results near the forward direction for ω, ρ, ϕ and Δ photoproduction are compared with a simple model involving only few Regge-trajectory exchanges. Particular attention was paid to the pion trajectory contribution and the possibilities of conspiracy and evasion were studied. It is found that ω and Δ photoproduction indicate a pion conspiracy. A special emphasis was made on the zero suggested by factorization from previous conspiracy fits. It is also shown that this zero is not able to explain ω and Δ photoproduction. That implies a violation of factorization and then a new difficulty of the pure Regge-phenomenology approach. (auth)

49394 THRESHOLD THEOREM FOR THE RADIUS OF THE $F_{2\gamma}$ NUCLEON FORM FACTOR AND THE EFFECT OF A DEGENERATE NEUTRINO SEA OF ELECTROMAGNETISM. Royer, Jeffrey Paul. Stanford, Calif.; Stanford Univ. (1969). 80p. University Microfilms Order No. 70-1595.

Thesis.

This dissertation consists of two separate distinct parts. In Part I, a method is developed for expanding the absorptive part of the sidewise dispersion relation for the nucleon $F_{2\gamma}$ radius. It is assumed that a threshold expansion is valid, which allows the exact first order terms in this expansion to be obtained in the limit of the pion mass going to zero. It is proved that the first order terms in this expansion come solely from the π-N intermediate state. Thus, the expansion provides justification for the retention of only the π-N intermediate state in a first attempt at describing the radius, as in Drell and Silverman. Furthermore, the expansion provides a handhold for attempting to estimate the corrections to the first order term coming from the 2 π-N and higher intermediate states. Part II starts with the fact that modern cosmological theories imply the existence of a universal degenerate Fermi sea of neutrinos. The fact that the Fermi energy K_f varies from theory to theory, could in principle be used to help decide which universe we live in. It is shown that a parity violating term is introduced into Maxwell's equations as a result of the neutrino sea. In particular it is studied whether a new, meaningful limit on the Fermi energy can be established by studying the propagation of light and the character of magnetic fields in such a neutrino sea. Unfortunately, the solutions to these equations show that the effect of the neutrino sea on electromagnetism is too small to be observed. (Diss. Abstr.)

49395 TESTS FOR ISOTENSOR COUPLINGS IN ELECTROMAGNETIC INTERACTIONS. Bergmann, Ernest Eisenhardt,

Princeton, N. J.: Princeton Univ. (1969). 76p. University Microfilms Order No. 70-8347.

Thesis.

The reaction first suggested by Dombey and Kabir to test for a possible isotensor coupling in the electromagnetic interaction, $\gamma + d \rightarrow N + N^*(1236)$, is studied here in great detail to ascertain its usefulness as a precision test for such couplings. A general survey of other possible reactions to test for isotensor terms is included in this work. Because of the importance of the reaction, $e^+ + e^- \rightarrow 3\pi$, a detailed analysis of this reaction is included in the appendix. (Diss. Abstr.)

49396 EFFECT OF THE COULOMB POTENTIAL ON THE π^- PHOTOPRODUCTION. Tzara, C. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys.; B18: 246-52(1970).

The influence of the electric field of the atom on the π^- photoproduction is discussed. Below threshold the pion is produced in an s-bound state and at threshold, the cross section rises very steeply. These features favor photoproduction as a tool to investigate nuclear properties and interactions with pions. Application is made to the reaction $\gamma + {}^{11}B \rightarrow {}^{11}C + \pi^-$. (auth)

49397 ANALYTIC REGULARIZATION, ELECTROMAGNETIC MASS DIFFERENCES, AND $\pi^0 \rightarrow 2\gamma$ DECAY. Becker, W.; Camerer, H.; Mitter, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nucl. Phys.; B18: 267-70(1970).

The electromagnetic mass splitting of baryons and the $\pi^0 \rightarrow 2\gamma$ decay rate is computed using the Feynman–Speisman model. Divergencies are treated by analytic regularization. The subtraction constant is determined from the observed proton-neutron mass difference. (auth)

49398 MESON EXCHANGE EFFECTS ON ELECTRON SCATTERING FORM FACTORS IN ^{12}C. Chemtob, Marc; Lumbroso, Albert (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Phys.; B17: 401-29(1970).

The role of meson-exchange currents in the excitation of nuclear states by electron scattering is investigated in the favorable case of ^{12}C. The description uses the noncovariant perturbative model based on the expansion of the mesic S-matrix in the interaction representation. Only the one-pion-exchange contributions to the long-range part of the two-body electromagnetic interaction are retained. When coming to the derivation of the multipole operators, the two-body local current densities are expanded around the c.m. of the pair of nucleons. The approximation is introduced chiefly to simplify the practical calculations, but it also allows the model to fulfil the requirement of charge conservation. Application of the model is made to the strongly excited isospin-one levels lying above 14 MeV excitation in ^{12}C. The electron scattering form factors are calculated with wave functions of the single particle-hole model and compared with data for momentum transfers extending up to 700 MeV/c. The exchange correction is found to be small for low values of the transfer but to grow substantially as the transfer increases; so much as to overcome the contribution of the one-body operators. The effect is always an increase of the form factors with a similar dependence on transfer as the one-body form factors. Comparison of the results for the impulse form factors with other recent theoretical calculations show a reasonable degree of model independence. The spin-orbit relativistic corrections to the one-body currents are also examined but are found to play a negligible role, particularly in the transverse interaction. (auth)

49399 ELECTROMAGNETIC PION FORM FACTOR AND THE ρ-RESONANCE. Lam, W. S. (Ecole Polytechnique, Paris). Nucl. Phys.; B17: 237-46(1970).

Under the elastic unitarity assumption, the electromagnetic pion form factor is directly related to the D-function of the $J = I = 1$, $\pi\pi$ partial wave amplitude in the N/D formulation. A twice-subtracted dispersion relation is used for the D-function. The two subtraction constants are determined by two self-consistency conditions, and Pagels approximation is used to avoid the solving of the coupled integral equations. The mass and width of ρ-resonance are determined from the best fit curve to e.m. pion form factor experimental data of the Orsay group. Their values are $m_\rho = 765$ MeV and $\Gamma_\rho = 116$ MeV. The rms electromagnetic pion radius is deduced from the slope of the curve at $s = 0$, $r_\pi = 0.67$ fm. (auth)

49400 SYMMETRY BREAKING AND CURRENT DIVERGENCES BELONGING TO $(3,3^*) + (3^*,3)$ AND $\eta \rightarrow 3\pi$ DECAY. Sarker, A. Q. (International Centre for Theoretical Physics, Trieste, Italy. Univ. of Islamabad, Rawalpindi, Pakistan). Nucl. Phys.; B17: 247-52(1970).

Through the pole model, the decay $\eta \rightarrow 3\pi$ is related to the $\pi\pi$ and $\pi\eta$ scattering processes, which are then evaluated with the assumption of PCAC, soft pion (eta) limits and the symmetry breaking Hamiltonian and current divergences belonging to the $(3,3^*) + (3^*,3)$ representation of $SU(3) \otimes SU(3)$. (auth)

49401 SPIN DEPENDENCE IN COMPTON SCATTERING BY POLARIZED ELECTRONS. Christillin, P. (Scuola Normale Superiore, Pisa, Italy); Remiddi, E. Lett. Nuovo Cim.; 4: 525-8 (19 Sep 1970).

In order to check the correctness of the theoretical predictions for scattering on free electrons, a previous calculation for the spin-dependent part is repeated independently. A concise summary is given of the main points of the calculation. The results are found to agree with the previous work. (J.F.P.)

49402 FINAL-STATE INTERACTIONS IN LARGE-MOMENTUM-TRANSFER INELASTIC ELECTRON–DEUTERON SCATTERING. Smith, R. (Cambridge Univ., Eng.); Wilkin, C. Lett. Nuovo Cim.; 4: 647-52(3 Oct 1970).

Various properties of the neutron–proton final-state interaction in large-momentum electron–deuteron scattering are calculated. (J.F.P.)

49403 GAUGE INVARIANCE CONDITION IN THE HIGH VIRTUAL-PHOTON MASS LIMIT. Shimizu, Y. (Tokyo Univ.). Lett. Nuovo Cim.; 4: 643-6(3 Oct 1970).

It is shown that the relative importance of various invariant amplitudes which appear in the gauge condition depends on the invariants to be made infinite. The gauge invariance imposes conditions on the different amplitudes corresponding to the high-energy limit or the high virtual-photon mass limit. The electroproduction of a charged scalar meson and the virtual Compton scattering are examined in the ladder model. (J.F.P.)

49404 FIXED POLES AND CHARGED-PION PHOTOPRODUCTION. Fayyazuddin; Riazuddin; Ahmad, M. (Univ. of Islamabad, Rawalpindi, Pakistan). Lett. Nuovo Cim.; 4: 633-7(3 Oct 1970).

A model for charged pion photoproduction is studied. A satisfactory fit for positive-pion photoproduction is obtained both for differential cross sections and polarization up to $t = -0.16$ $(GeV)^2$. (J.F.P.)

Weak

Refer also to abstract 49952.

49405 (INSJ–120) AVERAGE RANGE-ENERGY RELATION OF MUONS OF ENERGIES ABOVE 10^{12}eV AND ITS FLUCTUATION. Nagano, Motohiko (Tokyo Univ. (Japan). Inst. for Nuclear Study). 1 Jun 1970. 27p. Dep. CFSTI (U. S. Sales Only).

The average range energy relations of muons in standard rock are calculated under the several assumptions of the cross section of muon–nucleon interaction. The fluctuation of the range around the average is estimated by means of the Monte Carlo method. The energy spectra of the vertical muons at sea level derived from the depth-intensity relation are presented for the various assumptions considered. (auth)

49406 VENEZIANO MODEL FOR K_{l4} AND K_{l3} DECAYS. II. Toda, Azuma (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 43: 1109-11(Apr 1970).

The form factors in K_{l4} and K_{l3} decays are evaluated from the standpoint of scattering amplitudes in the Veneziano model and hard-meson PCAC constraints. (L.B.S.)

49407 DYNAMICAL ENHANCEMENT OF SYMMETRY BREAKING IN K_{l3} DECAY. de Alwis, S. O. (Univ. of Toronto). Phys. Rev., D; 2: 1346-9(1 Oct 1970).

The possible dynamical enhancement of the second-order symmetry-breaking corrections to a recently derived expression for the K_{l3} form factors is investigated. (auth)

49408 COMMENTS ON DUALITY AND NONLEPTONIC HYPERON DECAY. Pakvasa, Sandip (Univ. of Hawaii, Honolulu). Phys. Rev., D; 2: 1353(1 Oct 1970).

It is shown that the results of Nussinov and Rosner, for S-wave hyperon decay, do depend upon assuming current algebra and partially conserved axial-vector current, contrary to the claim made by them. (auth)

49409 ANSWER TO COMMENTS ON DUALITY AND NONLEPTONIC HYPERON DECAY. Nussinov, Shmuel (Tel Aviv Univ., Israel); Rosner, Jonathan L. Contract AT(11-1)-1764. Phys. Rev., D; 2: 1354(1 Oct 1970).

A recent result on duality in nonleptonic hyperon decay is clarified. (auth)

49410 WEAK INTERACTIONS WITH LEPTON–HADRON SYMMETRY. Glashow, S. L.; Iliopoulos, J.; Maiani, L. (Harvard

Univ., Cambridge, Mass.). Contracts N00014-67-A-0028; AF49 (638)-1380. Phys. Rev., D; 2: 1285-92(1 Oct 1970).

A model of weak interactions is proposed in which the currents are constructed out of four basic quark fields and interact with a charged massive vector boson. It is shown, to all orders in perturbation theory, that the leading divergences do not violate any strong-interaction symmetry and the next to the leading divergences respect all observed weak-interaction selection rules. The model features a remarkable symmetry between leptons and quarks. The extension of our model to a complete Yang–Mills theory is discussed. (auth)

49411 HIGHLY INELASTIC NEUTRINO–NUCLEON SCATTERING. Budny, Robert V. (Univ. of Maryland, College Park). Phys. Rev., D; 2: 1271-7(1 Oct 1970).

Lower bounds for cross sections for neutrino-nucleon scattering summed over final hadron states at large energy and momentum transfer are estimated assuming the usual current-current coupling, Regge behavior, and current-algebra sum rules. The cross sections are estimated using an added assumption of pointlike baryon constituents in nucleons. The cross sections compare well with CERN bubble-chamber data. (auth)

49412 WEAK INTERACTION CUTOFF AND STRONG INTERACTION OF INTERMEDIATE VECTOR BOSONS. Marshak, R. E. (Univ. of Rochester, N. Y.). pp 232-46 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

The universal (V,A)-current—current theory of weak interactions—which is so successful for low energy weak processes—breaks down at higher energies. A measure of this breakdown is the weak interaction cutoff Λ which turns out to have the surprisingly low value of about 5 Gev, independent of the hadronic strong interactions (as deduced from the $K_1^0-K_2^0$ mass difference). The hypothesis is examined that the low value of Λ is due to some form of strong interaction of the intermediate vector boson (W) which induces a "strong" form factor for W and thereby provides a "natural" cutoff at $\Lambda \simeq m_W$. The strong interaction of W can be due to an interaction with hadrons or to self-interaction. The model involving a strong W-hadron interaction is based on a Sakata-type triplet of W's(two neutrals and one charged) and a strong "quadratic" interaction of this W triplet with hadrons. The model involving the strong self-interaction of W's can be formulated in terms of a triplet of two charged W's and one neutral enjoying a strong cubic self-interaction. The second model provides a unified treatment of CP-conserving and CP-violating weak processes and predicts gross CP violation in weak processes to which the electromagnetic interaction contributes significantly. Experimental tests of both strongly interacting W models are discussed. (auth)

49413 FULL CONTENT OF LEPTON PAIR LOCALITY IN NEUTRINO PROCESSES. Pais, A. (Rockefeller Univ., New York); Treiman, S. B. Contract AF49(638)-1545. pp 257-60 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

A new general consequence of lepton pair locality is stated. It applies to any neutrino process in which the total number of incoming and outgoing particles exceeds four. This "azimuthal test" completes all general statements that can be made on the basis of locality alone, without more detailed dynamical input. (auth)

49414 WEAK INTERACTIONS MEDIATED BY EXOTIC MESON STATES. Arnold, Richard C.; Vossler, Charles (Argonne National Lab., Ill.). Progr. Theor. Phys. (Kyoto); 43: 1584-7(Jun 1970).

A model of semileptonic weak interactions is proposed, incorporating exotic vector-axial-vector mixtures which play the role usually assigned to intermediate bosons. It is shown that semileptonic interactions at high energy (400 GeV laboratory momentum) become as strong as electromagnetic interactions, both elastic and inelastic, in this model. (auth)

49415 POSSIBLE ANOMALOUS INTERACTION OF MUONS. Ng, S. H.; Sugano, R. (Dalhousie Univ., Halifax, Nova Scotia). Progr. Theor. Phys. (Kyoto); 43: 1588-95(Jun 1970).

In order to introduce a mechanism to induce the extraordinary muon mass in comparison with the electron mass, interactions with derivative coupling between muon and a hypothetical neutral vector boson are proposed. The muon self-energy and the muon anomalous magnetic moment (a.m.m.) arising from this interaction are calculated in the self-consistent method. The parameters involved are then investigated to see whether a large muon self-energy is compatible with its anomalous magnetic moment. The allowed upper limit for the ratio of the coupling constant and the vector boson mass is obtained within the experimental uncertainty and the theoretical value of the muon a.m.m. In these interactions, the hypothetical neutral vector-boson appears only in the intermediate state and no real neutral boson is created. In the high energy processes, the muon pair production by muon is proportional to the fourth power of the transferred momentum. Further, the recently discovered possible anomalous properties of high energy muon can be explained by this model. (auth)

49416 UPPER LIMITS FROM ANALYSIS OF $\bar{\nu}_e$, e^- ELASTIC SCATTERING. Chen, Herbert H. (Univ. of California, Irvine). Phys. Rev. Lett.; 25: 768-9(14 Sep 1970).

The result of the Reines–Gurr experiment is analyzed in terms of nonderivative four-fermion interactions. Upper limits for interactions other than V–A are shown to be lower than that for the V–A interaction. In particular, leptonic neutral-current interactions of the vector or axial-vector type are already constrained to be below the strength of a Fermi interaction. (auth)

49417 SIMPLE MODEL FOR THE THREE-BODY DECAYS OF $^4_\Lambda$H. Londergan, J. T. (Oxford Univ.). Nucl. Phys.; B16: 109-18(1970).

The decay spectra for $^4_\Lambda H \rightarrow \pi^- + p + {}^3H$ and $^4_\Lambda H \rightarrow \pi^- + n + {}^3He$ were calculated, using a two-channel reaction matrix model for the p^3H and n^3He final-state interactions. The qualitative features of the experimental ^3H and ^3He momentum distributions, which are quite different in character, are adequately reproduced with this model. (auth)

49418 DIFFRACTION MODEL OF HIGH-ENERGY LEPTONIC INTERACTIONS. Piketty, C. A.; Stodolsky, L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B15: 571-600(1970).

The cross sections for leptonic production of π, ρ and A_1 mesons and total leptonic cross sections are estimated using the meson-dominance assumptions. The comparison of the predictions with data on deep electroproduction total cross sections provides a partial check of the ideas of the model. Simple experimental implications of the model are given. In addition, independently of the model, it is shown that the experimental test of the PCAC hypothesis in neutrino scattering at small leptonic momentum transfer does not require a cut-off on the scattering angle, but only in the momentum transfer. (auth)

49419 NONLEPTONIC HYPERON DECAY AND CHIRAL SU(3) SU(3) ⊕ SU(3) SYMMETRY-BREAKING. Ohya, Katsuhiko (Nihon Univ., Tokyo). Soryushiron Kenkyu; 40: 131-46(Dec 1969). (In Japanese).

Nonleptonic decay is discussed from the viewpoint of the chiral SU(3) ⊕ SU(3) symmetry breaking. The Hamiltonian density of the nonleptonic hyperon decay is written. The result of the present calculation by hard pion approximation showed that the nonleptonic hyperon decay is expressed by $\mathcal{H}'(\mathbf{X})$ which is also the mass-term of baryon. The interaction Hamiltonian of the nonleptonic decay gave the result that the f/d ratio (−3.06) of scalar spurion in the hard pion approximation is consistent with that (−3.05) of mass splitting. The calculation also reproduced the experimental values of S and P waves consistently. The f/d ratio of pseudo-scalar spurion is also the same as that of Yukawa type interaction. (Japan)

49420 NON-LEPTONIC WEAK INTERACTION. Nakagawa, Masami (Nagoya Univ., Japan). Soryushiron Kenkyu; 40: D69-81(Dec 1969). (In Japanese).

The following two points concerning the nonleptonic interaction are introduced. The study to derive effectively the $\Delta I = \frac{1}{2}$ rule, even though the $\Delta I = \frac{1}{2}$ rule is not fulfilled at urbaryon level, is reviewed. Tadpole model is the first model for this rule. The theory is based on the nonrelativistic bound state model of baryons. The 56 dimension state in the SU(6) with the quark model was assumed to be a baryon state, and it was shown that $\Delta I = \frac{1}{2}$ transition was dominant in the ordinary $J \times J$ interaction. More general proof was also possible by using the SU(3) transformation and the CP invariance of $J \times J$ interaction. The absence rule is a method for searching the types of configuration for the special pairs of particles ($\bar{B}B$, $\bar{B}\pi$, $B\pi$) in the matrix element at the hadron level of nonleptonic decay. The meanings of the absence rule are the configuration absence and the pole absence. Comment on the sum rule is made. Furui and Trofimenkoff showed that factorization method, t-channel pole model and CA-PCAC method give almost the same result, and this fact resulted from the Okubo–Gell–Mann formula for baryon mass splitting and the similarity between the mass splitting and weak spurion. The proof of the similarity link may give some prospect of discovering the reason for the same result from a different theory. (Japan)

49421 NEUTRINO-INDUCED DISINTEGRATION OF THE DEUTERON. Allan, David A. New York; New York Univ. (1968). 121p. University Microfilms Order No. 70-7382. Thesis.

Neutrino induced disintegration of the deuteron is studied. The differential energy spectrum of the outgoing electron is calculated for E_ν = 12.0 MeV, which is that associated with a solar neutrino produced in the reaction $^8B \rightarrow {}^8Be + e^+ + \nu$ and unsuccessfully sought in experiments by T. L. Jenkins and R. Davis. Relativistic corrections to order $P_{Nucl}/M_{Nucl.}$ and meson corrections to the vector nucleon current are calculated at finite lepton momentum transfer by imposing CVC, taking a Yukawa S state wave function for the deuteron and plane waves for the outgoing protons. Meson contributions to the axial nucleon current are calculated in detail by constructing an effective axial current from intermediate states involving nucleon resonances, pions and meson resonances. The couplings in the intermediate states are derived from Goldberger–Treiman relations. The axial corrections are evaluated including nucleon recoil but at zero lepton momentum transfer. The effect of nucleon resonances is found to be nil but the contribution from an intermediate state involving a $\rho-\pi$ current weakly coupled to the leptons ~7% of the spectrum in the simple dipole approximation. Finally, the contribution of the D state of the deuteron to the electron spectrum is considered and the results are compared with those of Kelly and Überall who included final state interactions in a calculation using the dipole approximation. (Diss. Abstr.)

49422 CURRENT-ALGEBRA SUM RULES SUGGESTED BY THE PARTON MODEL. Smith, C. H. Llewellyn (CERN, Geneva). Nucl. Phys.; B17: 277-88(1970).

Those results which depend only on the weak and electromagnetic currents being carried by quarks are extracted from the parton model. It is shown that the most directly tested consequences of these results can be derived without the parton model if certain quark Hamiltonians are assumed and certain formal manipulations of operators are valid. Bounds and estimates are given for high-energy neutrino and anti-neutrino cross sections. (auth)

49423 FINAL-STATE INTERACTIONS AND CHARGE ASYMMETRY IN K_{β} DECAYS. Bell, J. S.; Zia, R. K. P. (CERN, Geneva). Nucl. Phys.; B17: 388-400(1970).

It is argued that final-state interaction effects can become appreciable only if certain CP violating amplitudes are unexpectedly large. If such large hitherto hidden violations exist, then variation of the asymmetry over the Dalitz plot can yield otherwise unobtainable information about them. (auth)

49424 WEAK STRUCTURE EFFECTS IN PION AND KAON DECAYS. Bailin, A.; Bailin, D. (Univ. of Sussex, Eng.). Nucl. Phys.; B17: 317-30(1970).

A charged W-boson is assumed to provide weak structure for the purely leptonic decay modes of the pion and kaon. The branching ratios of these modes including electronmagnetic corrections are recalculated and the cut-off dependence arising from a W-boson having general electromagnetic properties is explored. The radiative decay modes are studied both for the purpose of finding direct evidence for the existence of the W and also for the possibility of observing T-violation. (auth)

49425 FINAL-STATE COULOMB CORRECTIONS TO NEUTRINO REACTIONS. Nachtmann, O. (CERN, Geneva). Nucl. Phys.; B18: 112-24(1970).

Final-state Coulomb corrections to reactions ν + nucleus $\rightarrow \mu$ + final state are estimated for the differential cross section $(\partial^2\sigma)/(\partial q^2 \partial \nu)$ in a region of the kinematical variables where the nucleons inside the nucleus contribute incoherently. Here q^2 is the four-momentum-transfer squared and ν is the energy transfer of the leptons. Corrections of the order of 5% are found for heavy nuclei. (auth)

49426 ELASTIC SCATTERING OF LEPTONS ON DEUTERONS AND T-NON-INVARIANCE. Lin, Keh Ying (CERN, Geneva). Nucl. Phys.; B18: 162-72(1970).

The elastic scattering of polarized leptons (muons or electrons) on polarized deuterons was studied. The electromagnetic vertex of the deuteron is represented by four form factors, one of them violates T-invariance. Using the one-photon-exchange approximation, the differential cross section is expressed in terms of these form factors and the polarizations (initial and final) of leptons and deuterons. (auth)

49427 REGENERATION OF NEUTRAL KAONS. Nagy, Elemer. Fiz. Szemle; 20: 143-9(May 1970). (In Hungarian).

The neutral K^0 particle and its antiparticle $\bar{K}^0$, created in strong interactions, are unstable and undergo decay as the result of weak interactions; their vacuum decay is described by a Schrödinger equation in the neutral kaons' own system. The K^0 and $\bar{K}^0$ may interact with protons and neutrons. Regeneration involves elastic forward scattering, leaving unchanged the momentum and the direction of the particles; it may be best observed by observing the 2-pion final states on the basis of the $K \rightarrow 2\pi$ decay. Numerical calculations are presented on the basis of the correlation between the nonconservation of the CP symmetry and the K^0 regeneration, using the Regge pole model to express strong interactions in the asymptotic energy range on the basis of the Pomeranchuk phenomenon. The energy dependence of the regeneration parameter may also be derived by determining the resonances. Regeneration of neutral kaons will be studied experimentally in the near future at the Serpukhov laboratory in the Soviet Union. (TTT)

49428 WEAK CHARGE-RETENTION PROCESSES AND CP-NONCONSERVATION. Ahrens, T. (Georgia Inst. of Tech., Atlanta). Nuovo Cim.; 69A: 444-56(1 Oct 1970).

A previously discussed essentially permutation-symmetric weak interaction is extended to encompass strangeness-changing processes of the charge-exchange and the charge-retention variety. The charge-exchange part of the interaction has the presently accepted form. The charge-retention part is used in the calculation of various elementary processes. At present there is no disagreement with experiment. Predictions are made. (auth)

49429 Kl_3 PUZZLE AND CURRENT ALGEBRA. Banerjee, H. (CERN, Geneva). Phys. Lett.; 32B: 691-5(14 Sep 1970).

Sum rules for the on-shell scalar form factor $\{f_0(q^2)\}$ in Kl_3 decay show that the experimentally observed negative slope of $f_0(q^2)$ may be explained if chiral SU(2) symmetry is nearly exact. Our analysis further suggests that $f_0(q^2)$ should turn over and increase outside the physical region. (auth)

Strong (General)

Refer also to abstracts 49565 and 49617.

49430 (COO-264-558) HADRODYNAMICS AND QUARK STRUCTURE. Ellis, Stephen (California Inst. of Tech., Pasadena); Frampton, Paul H.; Freund, Peter G. O. (Chicago Univ., Ill.); Gordon, David (National Accelerator Lab., Batavia, Ill.). Aug 1970. Contract AT(11-1)-264. 51p. (EFI-70-49). Dep. CFSTI.

It is proved that conformal invariance of dual dynamics unambiguously fixes the possible quark configurations of all (exotic and nonexotic) hadrons. All these configurations follow a simple star of David rule. Rules for computing amplitudes for arbitrary hadronic processes involving external and/or intermediate exotic hadrons are given. The existence of quark diagrams such that one diagram has poles in all three channels of a four point function is pointed out. The total quark number of a hadron is identified with a Casimir operator of a new "D-spin" group. (auth)

49431 (NP-18418) SOLUTIONS OF BETHE-SALPETER EQUATION. Hadjioannou, F. T. (Athens Univ. (Greece). Dept. of Theoretical Physics); Kyriakopoulos, E. (Democritus Nuclear Research Center, Athens (Greece)). Jul 1970. 20p. Dep. CFSTI (U. S. Sales Only).

We study systematically and exhibit the Lorentz symmetry of the Bethe-Salpeter equation in the light-like case for two scalar quarks of different masses interacting via the exchange of a scalar photon. We develop a new approach for solving the eigenvalue problem of the equation for the general case (not only the light-like). Our method permits accurate analytic expressions for the spectrum and the wave functions. (auth)

49432 (SINP-TH-69-5) DYNAMICAL APPROACH TO HIGHER SYMMETRIES. Banerjee, H.; Dutta Roy, B. (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). [1969]. 34p. Dep. CFSTI (U. S. Sales Only).

It is shown that the family of sum rules recently proposed provides a very convenient framework for the realization of higher symmetry relations among the trilinear hadron couplings. These sum rules are derived assuming unsubtracted dispersion relations for the forward as well as the backward elastic hadronic scattering amplitudes corresponding to t-channel isospin (I) and G-parity $I^G = 1^+$, and ρ-dominance in the $I^G = 1^+$ channel. The remarkable feature of the sum rule is that for the scattering of hadrons of intrinsic parities η_1 and η_2 contributions from states with parity $\eta_1\eta_2$ are suppressed (for meson-meson scattering they are entirely absent). It is, therefore, argued that the sum rules for meson-meson and meson-baryon scattering considered will be very well saturated by the states belonging to the SU(6) 35-plet of negative parity mesons and the 56-plet of positive parity baryons respectively. The consistency of this principle of sat-

uration may be easily checked if one further assumes the universality of ρ-meson coupling to hadrons. To substantiate the validity of the last assumption, it was verified that its predictions are in excellent agreement with the values of the ρNN and ρKK coupling constants obtained from the sum rules. The hypothesis of universal ρ-coupling leads to relations among the trilinear meson couplings which may be identified as the "broken" SU(6) predictions. In the meson-baryon sector, assuming SU(3) symmetry, one obtains the SU(6) results in the static limit $(m_\rho/M_B) \to 0$, where m_ρ and M_B are the ρ-meson and baryon masses respectively. It is emphasized that in contrast with similar derivations based on other sum rules the present derivation is relatively free from ambiguities arising from arbitrary and sometimes untenable saturation assumptions. (auth)

49433 PRINCIPLE OF SEPARABILITY IN HIGH-ENERGY REACTIONS. Mori, Kenju; Nakamura, Hiroshi (Saitama Univ., Urawa, Japan. Aoyama Gakuin Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 43: 965-75(Apr 1970).

A new theory of high-energy hadronic collisions is proposed on the basis of the experimental evidences for the so-called H-quantum which was introduced by Hasegawa. (auth)

49434 REARRANGEMENT OF URBARYON LINES AND FORCES BETWEEN COMPOSITE HADRONS. Imachi, Masahiro; Oroguchi, Takashige; Otsuki, Shoichiro; Toyoda, Fumihiko (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 43: 1119-20(Apr 1970).

The urbaryon rearrangement diagrams are examined in connection with properties of forces between composite hadrons. (L.B.S.)

49435 INTERNAL STRUCTURE OF HADRONS UNDERLYING THE VENEZIANO AMPLITUDE. Takabayasi, Takehiko (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 1117-18(Apr 1970).

It is shown that the internal structure of hadrons underlying the Veneziano amplitude can be interpreted in the relativistic oscillator model which was formally considered in the scheme of multilocal theory if a definite internal force is assumed and the number of points N is sufficiently large. (L.B.S.)

49436 BETHE–SALPETER EQUATION WITH A NEAR HARMONIC INTERACTION. Sundaresan, M. K.; Watson, P. J. S. (Oxford Univ.). Ann. Phys. (N. Y.); 59: 375-407(Aug 1970).

The Bethe–Salpeter equation for the bound states of a quark-antiquark pair interacting is studied by means of a phenomenological interaction which is a relativistic generalization of the three-dimensional harmonic oscillator interaction. For scalar quarks an analytical expression is found for the square of the mass of the bound states which has a linear dependence on the orbital angular momentum between the quarks. Solutions of the equation also exist which can be interpreted as daughter states, with both natural and unnatural parity, although the wave functions for the unnatural parity states vanish identically for particles on the mass shell. For spinor quarks, equations for states with given J_{PC} are obtained, and, in the case of 0^{-+} and 1^{--} states, their spinor structures are shown to have a form required by Llewellyn Smith for explaining the Van Royen–Weisskopf paradox. The mass spectrum obtained in the spinor case is discussed, and the existence of a new kind of bound state is demonstrated. (auth)

49437 METHOD OF THE LOCAL CONSTRUCTION OF INVARIANT SUBSPACES IN THE SPACE OF SOLUTIONS OF THE CHEW–LOW TYPE EQUATIONS. Meshcheryakov, V. A.; Rerikh, K. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Ann. Phys. (N. Y.); 59: 408-25(Aug 1970).

In the introduction the nonlinear system of functional equations for the matrix elements of the S-matrix is formulated, which is called the Chew–Low type equations. A short review of some papers devoted to equations of this type is given, and the advantages of the approach of the present paper are discussed. The transition to the projective coordinates in the space of the matrix elements of the S-matrix and the linearization of the unitarity conditions are performed. An interpretation of the system of functional equations as a transformation in the $(n-1)$ dimensional real space is given. It is shown that the sum of the solutions of the initial system of equations is contained on the invariant hypersurfaces of this space. A method of the local construction of the invariant subspaces is proposed. The method suggested is applied to the Chew–Low equations with the 3×3 crossing matrix. It is established that, if the Chew–Low equations possess a solution, then the arbitrariness of the solutions of a certain class, being the generalization of the familiar β-arbitrariness, is not exhaustive. (auth)

49438 ANTIQUARKS IN THE UNIVERSE. Sakharov, A. D. (Dept. of Nuclear Physics, Moscow). pp 35-46 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

A hypothesis is proposed that in nature there exist stable electrically neutral antiquarks with average cosmic density corresponding to the baryon neutrality of the Universe. It is supposed that antiquarks are not captured by nuclei but possess a considerable scattering cross section. The existence of particles with above properties is associated with the hypothesis on cosmologic CPT symmetry and with the three-triplet quark model. (auth)

49439 SHORT-RANGE NUCLEAR FORCES AND HIGH-ENERGY CROSS SECTION BEHAVIOR. Logunov, A. A.; Nguyen Van Hieu; Khrustalev, O. A. (Joint Inst. for Nuclear Research, Dubna, USSR. Inst. for High Energy Physics, Serpukhov, USSR). pp 90-107 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

Some restrictions on the behavior of elastic and inelastic cross sections are obtained as consequences of analyticity and unitarity. The connection between the analytic properties of the scattering amplitude in momentum transfer and the short-range character of strong interactions is studied. (auth)

49440 QUARK MODEL AND HADRON INTERACTIONS. Akhiezer, A. I.; Rekalo, M. P. (Physical-Technical Inst., Kharkov). pp 197-216 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

In the quark model of elementary particle interactions an investigation is made of the following hadron scattering processes: photoproduction of neutral vector mesons on nucleons at high energies, elastic and inelastic diffraction scattering of hadrons at high energies and small momentum transfers, production of low-energy vector mesons in $\pi N \to \overline{K}N$, γN collisions. The quark model allows one to relate the cross sections for photoproduction of neutral vector mesons and those for hadron elastic scattering. This permits, in turn, to find the relations between the cross sections of photoproduction of ω, ρ, φ mesons on protons and on neutrons, to explain the dependence of the differential cross sections of these processes on the squared momentum transfer as well as the energy dependence of the total and differential cross sections for vector meson production at zero angle. From comparison of the differential cross sections of pp and $\bar{p}p$ elastic scattering in the quark model it is seen that the quark–quark scattering amplitude must show only one (main) diffraction peak while the antiquark–quark scattering amplitude must show several diffraction peaks. It is shown that the difference in quark amplitudes leads to that in processes $\pi^+ + p \to \pi^+ + p$, $K^- + p \to K^- + p$, $\bar{p} + p \to \bar{n} + n$, $\pi^- + p \to \pi^0 + n$, $K^- + p \to \underline{K}^0 + n$, $p + p \to A + A$ there must be observed several maxima while in processes $K^+ + p \to K^+ + p$, $K^+ + n \to K^0 + p$, $n + p \to p + n$ only one main diffraction maximum exists. The relations are found between the cross sections of different processes in the range of momentum transfers corresponding to the second diffraction maximum. The predictions of the model are compared with experiment. A model which is based on the analogy between a nucleus emitting γ-quanta and the quark system emitting vector mesons is suggested for vector meson photoproduction near the threshold. Relations between different cross sections for vector meson production are found, the angular dependence of the cross sections for vector meson production in πN, $\overline{K}N$, $-N$ interactions near the threshold as well as the angular distribution of the decay products of vector mesons are predicted. The suppression of $\bar{p}p$ annihilation in s-state into two vector mesons is accounted for. The experimental data prove the predications of this mode. (auth)

49441 DIFFRACTION DISSOCIATION AND EXCHANGE PROCESSES IN THE REGGE MODEL OF MANY-BODY COLLISIONS. Van Hove, L. (CERN, Geneva). pp 217-27 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

An attempt is made to classify many-body hadron collisions at high energy by using the multiperipheral Regge model with the additional assumption that at most one Pomeranchuk trajectory is exchanged. The collisions are grouped in diffraction dissociation and exchange processes, the latter forming two subgroups, intrinsic exchange which depends only on internal quantum numbers of the outgoing particles and extrinsic exchange which depends also on their momenta. These categories generalize to many-body processes the well known distinction made for two-body collisions between diffraction scattering, backward elastic scattering and scattering with exchange of internal quantum numbers. The problem of factorization for

diffraction dissociation processes is briefly discussed and a final remark is devoted to possible limitations of the model. (auth)

49442 HADRONIC MATTER. Tati, Takao (Univ. de Campinas, Sao Paulo, Brazil). Progr. Theor. Phys. (Kyoto); 43: 1596-1612(Jun 1970).

The hadronic phenomena are described by a basic field with a nonlinear coupling. An essential assumption is the cutoff of momentum degree of freedom of the basic particle which refers to a universal vector. The ground state of hadronic matter is obtained by solving the Schrödinger equation under simplified conditions. It is a cloud of a number of basic particles and their antiparticles, and is considered to give a hadron core. The excited states of hadronic matter are inferred correspondence-theoretically by using a Fermi-gas model and by referring experimental facts. Hadron resonances and fireballs are considered to be different modes of excitation of hadronic matter. This picture allows a quantum of some hundreds MeV for resonances and a H-quantum (constant-mass-fireball) of a few BeV. The three parameters reflecting our basic assumptions, the mass M, the coupling constant l and the cut-off length Λ, are interrelated in the theory and only one parameter remains free without changing our picture. Owing to the cutoff referring to the universal vector, the Lorentz factor $\gamma = (1-\beta^2)^{-\frac{1}{2}}$ of hadronic matter cannot exceed a certain value γ_{max} if we take a straight cutoff. For Λ 10^{-15} cm and Λ = 10^{-18} cm, γ_{max} turns out to be $3 \cdot 10^5$ and $3 \cdot 10^8$, respectively. Though the cutoff may have a tail, the production probability of a matter with $\gamma > \gamma_{max}$ is expected to be small and the existence of a "giant" fireball seems probable. (auth)

49443 SU(3) SYMMETRY BREAKING PARAMETER IN A QUARK MODEL. Kamal, A. N. (Univ. of Alberta, Edmonton). Nucl. Phys.; B15: 637-40(1970).

Spectral function sum rules recently derived are used to evaluate the symmetry breaking parameter c, the coefficient of u_8-term in the quark Lagrangian. If $\langle u_8 \rangle = 0$ (vacuum expectation value) then c is found to be ≈ -1.23 with $F_\pi = F_K = F_\eta$. If experimental value for F_K/F_π is used c is -1.30 ± 0.01. However, if $u_8 \neq 0$ there is a solution with c small and of order m_π^2/m_K^2. (auth)

49444 EXTENSION OF THE IIZUKA RULE AND UNITARITY. Sawada, Shoji (Nagoya Univ., Japan). Soryushiron Kenkyu; 40: D89-92(Dec 1969). (In Japanese).

The extension of the Iizuka rule and unitari. is discussed. The inequality in the strong decay of a meson to two body Tr(M) Tr(MM) ≪ Tr(MMM) was explained by Iizuka as the produced pair of urbaryon is not the component of the same hadron. (Rule A). However, it is possible to say that three mesons connected by urbaryon are allowed. (Rule B). The difference between the rule (A) and the rule (B) appears in case of more than four hadron or exotic resonances. The analysis of high-energy hadron-hadron scattering with rearrangement diagrams resulted in that the rule (A) can explain the diffraction scattering and the quasi-diffraction process such as $\pi + p \rightarrow A + p$. The rule (A) is considered to be the expression of many body collective motion which includes the cloud produced by the interaction of invariant SU(3). It is one of the effects of unitarity that the structure of the differential cross section of proton-proton elastic scattering at high energy is explained by double scattering. The cross-over which is a point of discussion in the Regge theory and the difference of the slope of the differential cross section of elastic scattering are also explained by the effect of unitarity. (Japan)

49445 INVESTIGATION ON THE MODELS OF ELEMENTARY PARTICLES AND THE BREAKING OF SYMMETRY. Maki, Ziro (Kyoto Univ.). Soryushiron Kenkyu; 40: D82-6(Dec 1969). (In Japanese).

The investigation of the models of elementary particles and of symmetry breaking are reviewed. The quartet model (model (a)), single triplet model (model (b)) and three triplet model (model (c)) have been acceptable on the basis of criteria that a model gives SU(3) and can classify low-lying baryons into 8 and 10 and that the model should have good current algebraic structure. The model (a) is rejected when the unitary singlet component of electromagnetic current is checked. The decay of π^0 can be used to judge the model (a), (b) or (c), but the theory concerning the π^0 decay is still not reliable. The theory given by Okubo showed that $S = \frac{1}{2}$ in the model (c) is the only one solution when the soft-pion limit is taken according to the modified PCAC by Adler, whereas Otokozawa and Suura obtained a result that $S = -\frac{1}{2}$ in the model (c) is also acceptable. It was shown by Maki and Umemura that the model (b) is also consistent with experiment. Problems on the symmetry breaking are considered with a diagram, which is presented. (Japan)

49446 GENERALIZED VENEZIANO MODEL FOR n PARTICLES, TRAJECTORIES WITH SIGNATURE. Koba, Z.; Nielsen, H. B. (Univ. of Copenhagen). Nucl. Phys.; B17: 206-20(1970).

Requiring definite signatures of all the parent and daughter trajectories involved in the n-meson Veneziano amplitude, a set of constraints on the parent trajectories is derived, which is a generalization of Veneziano's relation, $\alpha_s + \alpha_t + \alpha_u = 2$. (The mass formulas implied by them are compared with experimental values in the case n = 5.) The signatures to be ascribed to parent trajectories have to fulfil certain consistency conditions. (auth)

49447 ADVANCE NOTICE ON THE VENEZIANO MODEL OF QUARKS AND THE QUARK DYNAMICS. Hori, Shoichi (Kanazawa Univ., Japan). Soryushiron Kenkyu; 40: D50-1(Dec 1969). (In Japanese).

The program for the study on the relation between the Veneziano model and the quark model is shown. The Veneziano model seemed to hold good for hadrons, but furthermore it may apply at the level of quarks. The S-matrix element for quarks is to be given by the N-body Veneziano amplitude, so that the quark dynamics may be inferred. The quark dynamics is, however; approximate in the sense that the Veneziano amplitude does not satisfy unitarity. In order to try to presume the true quark dynamics, it may be easier to introduce unitarity at the stage of the quark dynamics than at the stage of treating the Veneziano amplitude of hadrons. (Japan)

49448 INVARIANT MEASURE AND THREE-CLUSTER REPRESENTATIONS OF THE VENEZIONO n-POINT FUNCTION. Koba, Ziro (Univ. of Copenhagen). Nucl. Phys.; B18: 253-66 (1970).

A general expression for the invariant volume element (measure) in the integral representation of the Veneziano n-point function is found, which is valid for an arbitrary choice of a set of (n-3) independent conjugate variables. Applying this, a three-cluster representation of the six-point function is given, which leads to the known form of Reggeization in a 3-to-3 reaction, keeping its symmetric form, and which also describes a smooth transition from double to triple Reggeization in a 2-to-4 reaction. An expression for the three-cluster representation of the n-point function can also be written down. (auth)

49449 PARTON MODEL AND INELASTIC HIGH-ENERGY HADRON–HADRON SCATTERING. Fritzsch, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Lett. Nuovo Cim.; 4: 291-7(15 Aug 1970).

An attempt is made to connect the hadron–hadron scattering in the deep inelastic region with a parton structure of the hadrons. A model is constructed that fulfills the following assumptions: two-fireball description of inelastic processes; parton exchange between two colliding hadrons; no charge exchange between the two hadrons at very high energy; G_{tot} independent of s; and limitation of the energy-momentum transfer t. (L.B.S.)

49450 $\bar{p}p$ ANNIHILATIONS AT REST INTO FOUR PIONS. Diaz, J. (CERN, Geneva); Gavillet, Ph.; Labrosse, G.; (and others). Nucl. Phys.; B16: 239-71(1970).

A sample of 6665 annihilations of the type $\bar{p}$(at rest)p → $\pi^+\pi^-\pi^+\pi^-$ is analyzed. Mass and angular distributions are given. A maximum-likelihood analysis is made which uses interferring Bose-symmetrized amplitudes to parametrize the reaction in terms of final-state 2π and 3π interactions. The dominant final state from $^1S_0$ annihilations is $A_2^+\pi^-$, where A_2 observed has M = 1335 ± 15 MeV, $J^P = 2^+$ and a decay $A_2 \rightarrow \rho\pi$. The important final states from $^3S_1$ annihilations are $\rho\pi\pi$ (s-wave ππ) and $\rho^0 f^0$. There is evidence for structure in the (I = 0, J = 0) ππ system. (auth)

49451 POSSIBLE TESTS OF THE VALIDITY OF CURRENT ALGEBRA OR FIELD ALGEBRA COMMUTATORS. Bietti, A. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Lett. Nuovo Cim.; 4: 529-34(19 Sep 1970).

Sum rules derived from commutators from the quark model and from field algebra are examined to determine whether a reasonable saturation of them can give some indications in order to choose between current algebra and field algebra commutators. It is concluded that there is some indication that favors the quark model, although definite evidence cannot be found. (J.F.P.)

49452 POMERANCHUK THEOREM AND THE RESULTS FROM SERPUKHOV AND SATELLITE EXPERIMENTS. Mohapatra, R. N.; Narayan, D. S. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Lett. Nuovo Cim.; 4: 535-40(19 Sep 1970).

The significance of some results from $K^- + p$ and $K^+ + p$ inter-

actions measured at Serpukhov and indications from Russian satellite experiments that inelastic p + p cross sections rise by 20% are discussed relative to the Pomeranchuk theorem. Three forms of the Pomeranchuk theorem are distinguished, and three theorems regarding these forms are stated and proven. It is concluded that the experimental results are thus far not conclusive regarding the validity of the Pomeranchuk theorem. (J.F.P.)

49453 INTERFERENCE AMPLITUDES FROM DUAL MODELS. Venturi, G.; Zakrzewski, W. J. (Cambridge Univ., Eng.). Nuovo Cim.; 69A: 431-43(1 Oct 1970).

The possibility of constructing interference amplitudes from dual models is examined. It is found that this is possible by abandoning the meromorphic approximation and introducing cuts along the positive real axes in the complex planes of the invariant variables. The discontinuities of the interference amplitudes constructed are studied and it is found that the contribution of these cuts can be made to drop off arbitrarily quickly. The same methods introduced for interference amplitudes are then applied to the construction of interference models for amplitudes involving many pions and it is indicated how similar amplitudes can be constructed for many pions plus two fermions. These amplitudes have the correct factorization properties and Regge behavior, no ancestors, no parity doubling (on leading or daughter trajectories), or degenerate leading trajectories. Of course they have the above-mentioned analyticity properties. (auth)

49454 SCHWINGER TERMS IN AN ALGEBRAIC QUARK MODEL. Mendes, R. V.; Ne'eman, Y. (Tel-Aviv Univ., Israel. Univ. of Texas, Austin). Phys. Lett.; 32B: 696-99(14 Sep 1970).

Using Jacobi's identity it is proved that the SU(6) × SU(6) local algebra of the quark model currents cannot be extended in a consistent manner by a set of c-number Schwinger terms. A modified quark model is proposed, whereby the Schwinger terms are operators required to close together with the currents within a local U(12) algebra. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 49542.

49455 (DEMO-70/9) LOW ENERGY $\pi-\pi$ RESONANCES IN THE VENEZIANO MODEL. Antoniou, N. G.; Papaioannou, G. M. (Democritus Nuclear Research Center, Athens (Greece)). May 1970. 13p. Dep. CFSTI (U. S. Sales Only).

An attempt is made to impose elastic unitarity on the forward $\pi-\pi$ scattering using the Veneziano amplitude together with a crossing symmetric subtraction term as an input. The N/D method is used and the ρ,ϵ mesons are interpreted as CDD poles. The self consistency requirement led to the evaluation of the low energy parameters and the S and P-wave phase shifts. The values of the scattering lengths obtained are $a_0^0 = 0.084\ m_\pi^{-1}$, $a_2^0 = -0.024\ m_\pi^{-1}$, $a_1^1 = 0.047\ m_\pi^{-3}$. (auth)

49456 (DEMO-70/13) GROUP THEORETICAL CALCULATION OF THE VENEZIANO PARTIAL WIDTHS FOR $\pi-\pi$ SCATTERING. Kyriakopoulos, E. (Democritus Nuclear Research Center, Athens (Greece)). May 1970. 18p. Dep. CFSTI (U. S. Sales Only).

A general formula of the Veneziano partial widths for $\pi^+\pi^-$ elastic scattering is obtained within the group SO(3,2). Recursion relations for the "widths" are given. (auth)

49457 (RLO-2041-41) ON A MODEL OF $\epsilon \to 2\gamma$ AND $\delta \to 2\gamma$ DECAYS. Sarker, A. Q. (Oregon Univ., Eugene). [1970]. Contract AT(45-1)-2041. 10p. Dep. CFSTI.

A model of DeCelles and Goehl for $\epsilon \to 2\gamma$ decay is generalized so as to give the correct SU(3) symmetric result for both $\epsilon \to 2\gamma$ and $\delta \to 2\gamma$. The question of symmetry breaking is also discussed. (auth)

49458 (SINP-TH-69-4) $\pi-\pi$ SCATTERING LENGTHS FROM A CLASS OF NONLINEAR LAGRANGIAN MODELS. Khare, Avinash V.; Pradhan, T. (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). [21 Mar 1969]. 15p. Dep. CFSTI (U. S. Sales Only).

A class of nonlinear Lagrangian models is proposed, most of which give S-wave $\pi-\pi$ scattering lengths that are widely different from those obtained from Weinberg's Current Algebra calculations. (auth)

49459 FINITE-ENERGY SUM RULES AND DUALITY OF SAKATON REARRANGEMENT DIAGRAMS. Imachi, Masahiro (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 43: 1021-34(Apr 1970).

It will be found that the amplitude X (a sakaton rearrangement amplitude with the t-u channel duality) should behave as repulsive backgrounds and the amplitude H (a sakaton rearrangement amplitude with the s-t channel duality) should behave as resonances at low energies, in order to reproduce the high energy behavior correctly, i.e., a prominent negative real part of X and a positive imaginary part of H. (auth)

49460 NONLOCAL FIELD THEORY OF THE QUARK MODEL. II. Sogami, Ikuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 1050-70(Apr 1970).

The nonlocal field theory of the quark model is developed by performing the second quantization and postulating interactions among mesic states. As an application, the high energy $\pi-\pi$ scattering amplitude is calculated in the lowest order perturbation approximation and is found to exhibit definitely the desirable Regge behavior. Further, the electromagnetic interaction of hadrons is formulated in a phenomenological way using the generalized current-field identity, and the electromagnetic form factor of pion is examined. (auth)

49461 UNITARIZED VENEZIANO MODEL WITH SATELLITES FOR $\pi\pi$ SCATTERING. Scott, David M.; Tanaka, K.; Torgerson, R. (Ohio State Univ., Columbus). Contract AT (11-1)-1545. Phys. Rev., D; 2: 1301-7(1 Oct 1970).

Single-channel unitarity on a five-term Veneziano $\pi-\pi$ amplitude using the K-matrix approach. The violation of crossing symmetry as measured by the s- and p-wave crossing-symmetry sum rules is found to be negligible for wide ranges in the satellite coefficients. The conditions imposed by the nonnegativity of the widths of the ρ, f, and g mesons as well as all their daughters are studied. Although these conditions still permit a continuous infinity of solutions, a limiting case is of some interest where the widths of the ϵ', ϵ'', and f' are made to vanish. For this special model widths, scattering lengths, and the phase shifts δ_0^0, δ_2^0, and δ_1^1 are calculated. Since the daughters are no longer degenerate with the parents, masses are also calculated. (auth)

49462 UNITARITY EFFECTS IN THE VENEZIANO MODEL. Humble, Stephen (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., D; 2: 1308-14(1 Oct 1970).

It is assumed that the Veneziano model in some ways represents a good approximation to the scattering amplitude and as such already contains the effects of numerous coupled, inelastic channels. This hypothesis is used to calculate the absorption parameters for pion-pion scattering below 2 GeV using a partial-wave dispersion relation, where some simple forms for the phase shifts are assumed. The results are compared with other analyses and extended to the case of pion-kaon scattering. Some implications of these results are discussed, and the problem of the presence of the Pomeranchukon is outlined. (auth)

49463 PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT CHECK ON THE CONSISTENCY AMONG + PARITY MESON COUPLINGS IN THE QUARK MODEL. Mitra, A. N. (International Centre for Theoretical Physics, Miramare, Italy). Phys. Rev., D; 2: 1327-9(1 Oct 1970).

The supermultiplet coupling constant $\bar{g}_1$ for the transition from $L^P = 1^+$ meson states to those of $L^P = 0^-$ in a relativistically boosted SU(6) × O(3) quark model developed previously by the author is evaluated by exploiting the connection between the $A_1\rho\pi$ and $\rho\pi\pi$ couplings in the model via partial conservation of axial-vector current and Weinberg sum rules. The new determination of $\bar{g}_1$ is in excellent agreement with its value obtained earlier from a direct fit to the experimental decay widths. (auth)

49464 BARYON-ANTIBARYON SCATTERING IN THE QUARK MODEL. Sastry, C. V.; Misra, S. P. (Regional Engineering Coll., Rourkela, India). Phys. Rev., D; 2: 1315-16(1 Oct 1970).

Proton-antiproton and neutron-antiproton scattering are calculated in the quark model, and it is observed that SU(3) violation should be taken into account in the quark-antiquark space to obtain agreement with experimental data. (auth)

49465 CONSTRAINTS ON THE DERIVATIVES OF THE $\pi\pi$ SCATTERING AMPLITUDE FROM POSITIVITY. Common, A. K. (CERN, Geneva); Yndurain, F. J. Commun. Math. Phys.; 18: 171-8(1970).

Conditions derived from positivity are given both above and below threshold for the derivatives of the $\pi\pi$ scattering amplitude. (auth)

49466 BARGMANN-WIGNER METHOD IN GALILEAN RELATIVITY. Hagen, C. R. (Univ. of Rochester, N. Y.). Commun. Math. Phys.; 18: 97-108(1970).

The equations of motion of a spin-one particle as derived from Levy-Leblond's Galilean formulation of the Bargmann-Wigner equations are examined. Although such an approach is possible for the case of free particles, inconsistencies which closely parallel

those encountered in the Bargmann–Wigner equations of special relativity are shown to occur upon the introduction of minimal electromagnetic coupling. If, however, one considers the vector meson within the Lagrangian formalism of totally symmetric multispinors, it is found that the ten components which describe the vector meson in Minkowski space reduce to seven for the Galilean group and that in this formulation no difficulty occurs for minimal electromagnetic coupling. More generally it is demonstrated that one can replace Levy–Leblond's version of the Bargmann–Wigner equations by an alternative set which leads to the correct number of variables for the vector meson. A final extension consists in the proof that for all values of the spin the (Lagrangian) multispinor formalism implies the Bargmann–Wigner equations. Thus the problem of special relativity of seeking a Lagrangian formulation of the Bargmann–Wigner set is found to have only a somewhat trivial counterpart in the Galilean case. (auth)

49467 CALCULATION OF A_1 AND B-MESON DECAYS USING SUM RULES AND THE VENEZIANO MODEL. Pancheri-Srivastava, Giulia (Northeastern Univ., Boston). Nucl. Phys.; B15: 525-39(1970).

The decay rates of A_1 into $\rho\pi$ and B into $\omega\pi$ are calculated from a study of the process $\pi A_1 \to \pi\omega$. The rates are obtained using finite energy dispersion relations (FEDR) as well as the Veneziano model. The results of the Veneziano model agree with those from FEDR under a certain hypothesis on the ρ-trajectory slope. Under this hypothesis the Veneziano model predicts for the anomalous magnetic moment of A_1 the value $\lambda_A = 0$, which is consistent with current algebra. We also obtain the angular distribution for the decay $B \to \pi\omega$ in agreement with a phenomenological analysis. (auth)

49468 APPLICATIONS OF THE EMBEDDING OF NON-LINEAR MESON TRANSFORMATIONS IN A EUCLIDEAN SPACE. Isham, C. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B15: 540-8(1970).

The embedding of the nonlinear pseudoscalar chiral realization space into the Euclidean space R^{15} is used to clarify the connection between the linear and nonlinear chiral theories and to construct symmetry-breaking terms. This connection is then extended to include octets of gauge particles. (auth)

49469 CHIRAL SU(3) x SU(3) THEOREMS FOR PSEUDOSCALAR–PSEUDOSCALAR SCATTERING AMPLITUDES. Osborn, Hugh (Queen Mary Coll., London). Nucl. Phys.; B15: 501-24(1970).

The set of all soft-meson theorems for all scattering amplitudes of the pseudoscalar octet, with two particles off shell, employing PCAC for each pseudoscalar state, current algebra and σ-terms following from $(3, \bar{3}) + (\bar{3}, 3)$ breaking of chiral SU(3) × SU(3) symmetry is given. The approximation to the scattering amplitude in the low-energy region by a linear expansion in the invariants is uniquely determined by the absence of exotic σ terms for $\pi\pi$ (as was first shown by Weinberg) πK and KK scattering, when $F_\pi = F_K$ is also required for consistency. To derive the linear expansions for amplitudes involving the η, $(3, \bar{3}) + (\bar{3}, 3)$ breaking is used in an essential manner; then the value of the symmetry breaking parameter c given by Gell–Mann, Oakes and Renner, the coupling of scalar densities to pseudoscalar states and the usual octet mass formula are naturally recovered. The application of the Adler consistency condition to the Veneziano formulas for pseudoscalar scattering, and its connection with chiral symmetry, are discussed. It is shown that the Adler condition can be justified only when there are exotic channels present. (auth)

49470 HARD-KAON AND -PION CALCULATIONS OF THE DECAYS $K_A \to K\rho$ AND $K_A \to K^*\pi$. Srivastava, Prem P. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Nucl. Phys.; B15: 461-76(1970).

The strong decays $K_A \to K\rho$, $K^*\pi$ are discussed in a current algebra approach by writing unsubtracted dispersion relations for the matrix elements of appropriate retarded commutators of currents or current divergences between single-particle states and vacuum, at (arbitrary) fixed linear combination of the two momentum transfers. This allows the pole contributions from both the variables to be retained. Moreover, the various form factors appearing in the calculation are allowed to satisfy at most once-subtracted dispersion relations and are treated on equal footing. The current algebra method is used to set up sum rules among the coupling constants and the subtraction constants without using the hypothesis of partial conservation of axial current. Their solution allows the partial-decay widths to be calculated as well as the Weinberg sum rules rederived as self consistency conditions. (auth)

49471 CHIRAL METRIC MESON LAGRANGIANS. Barnes, K. J.; Isham, C. J. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B15: 333-49(1970).

The currents associated with the chiral-invariant pseudoscalar meson Lagrangian, constructed from a certain metric tensor on a G-manifold, are investigated. The relation between these currents, the Sugawara model and the linearized version of chiral theories in which a set of free fields is constrained, is demonstrated. The techniques are then extended to include octets of vector and axial-vector mesons. (auth)

49472 PARTIAL-WAVE ANALYSIS OF THE 3π DECAY OF THE A_2. Ascoli, G.; Brockway, D. V.; Crawley, H. B.; Eisenstein, L. B.; Hanft, R. W.; Ioffredo, M. L.; Kruse, U. E. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 25: 962-5(5 Oct 1970).

A new partial-wave analysis is applied to the 3π decay of the A_2^- in the reaction $\pi^- p \to p\pi^+\pi^-\pi^-$ at 5 and 7.5 GeV/c. The relative importance of the spins and parities 0^-, 1^+, 1^-, 2^+, and 2^- are obtained as a function of 3π mass. Only the 2^+ spin and parity shows resonant structure. Results are also given on the polarization and momentum-transfer dependence of the A_2 and on the mass dependence of the interference of 1^+ background with 2^+ resonance. (auth)

49473 $K\pi$ PHASE SHIFTS FROM K_{l3} DECAY. Pham, Xuan Yem; Sazdjian, Hagop (Institut de Physique Nucleaire, Paris). Nucl. Phys · B17: 27-37(1970).

The S- and P-wave $K\pi$ phase shifts which are connected to the K_{l3} form factors are discussed by the dispersion relation approach. Also the K^* (890) resonance dominates the $K\pi$ P-wave. It is found that plausible phase shifts can be obtained only when $|\xi_0| < 0.5$ and $\beta \approx 10^{-2}$ (where ξ_0 and β are defined by $f_-(s)/f_+(s) = \xi(s) = \xi_0 + \beta s/m_\pi^2$). An S-wave $K\pi$ interaction would be quite unusual if $\xi(s)$ is negative and large (say $\xi < -0.5$). Existence of the κ-meson seems to be improbable if $\xi < -0.3$. The case of the zeros of the form factors is also discussed. (auth)

49474 $\pi\pi$, πK, AND KK VENEZIANO AMPLITUDES AND CURRENT ALGEBRA. Osborn, Hugh (Queen Mary Coll., London). Nucl. Phys.; B17: 141-67(1970).

The Veneziano amplitudes of $\pi\pi \to \pi\pi$ and $\pi K \to \pi K$ are used to extrapolate the results of current algebra from the soft-pion or soft-kaon limit when any pair of mesons are taken off the mass shell. The SU(3) × SU(3) symmetry breaking theory of Gell–Mann, Oakes and Renner is assumed and predictions made for the normalizations of the Veneziano amplitudes and resonance decay widths, the magnitudes of matrix elements of current algebra σ terms, the value of the symmetry breaking parameter c, F_K/F_π. Expressions are found for the K_{l3} form factors from the Veneziano amplitudes for $\pi K \to \pi K$ and $\pi K \to \pi K_A$. It is shown that current algebra cannot be similarly applied to the Veneziano amplitude for $KK \to KK$. (auth)

49475 GAUGE INVARIANCE PRESCRIPTIONS FOR PHOTOPRODUCTION AMPLITUDES. Ader, J. P.; Capdeville, M.; Salin, Ph. (Laboratoire de Physique Theorique, Bordeaux). Nucl. Phys.; B17: 221-36(1970).

It is shown that the gauge condition for a massless particle should be considered as a usual kinematical constraint, in fact a low-energy theorem, which has no dynamical implications for photoproduction reactions, and in particular, that it gives no prescription on the nature of dynamical singularities for the scattering amplitude (fixed poles, moving poles, conspiring poles, cuts, Kronecker-delta singularities, etc....) which are all allowed. It is also proved that no peculiar philosophy with regard to duality is imposed by gauge invariance. A special attention is devoted to π exchange and it is shown that $\pi^- p \to \rho_0^0 n$ does have structure in the forward direction expected in the very particular case where ρ^0-polarization is measured in the Jackson frame. Some implications for vector dominance are deduced, and more generally, a very simple prescription is given to compute scattering amplitudes describing vector-meson production (or electroproduction) which goes smoothly to the photoproduction amplitude when the vector-meson mass goes to zero. (auth)

49476 REGGE POLES AND SCATTERING LENGTHS. Stern, J.; Zaoui, R. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; B17: 253-66(1970).

The cut-off-free method based on a new form of the finite-energy sum rules is proposed, which permits one to reconstruct exactly the scattering amplitude at threshold, starting from a given form of its absorptive part at (arbitrarily) high energy. It is shown that the threshold behavior of partial waves imposes rather strong constraints on the high-energy form of the scattering amplitude and an example of the high-energy behavior satisfying these constraints is constructed. The method is used to calculate the s- and p-wave scattering lengths of the $I_t = 1$ $\pi\pi$ scattering, dominated at high energies by the ρ-trajectory. (auth)

49477 DUALITY AND THE VENEZIANO MODEL FOR VECTOR-SCALAR SCATTERING. Canning, G. P. (Oxford Univ.). Nucl. Phys.; B17: 359-87(1970).

A general procedure is developed for the analysis of elastic (ps) scalar-(ps) vector scattering on the Veneziano model, which avoids parity doublets on the leading trajectories and which, by a refinement of technique, demonstrates a "natural" solution with normal and abnormal parity trajectories spaced one unit apart. Comments are made on the "unsignatured" nature of the abnormal parity trajectories and the application of the Adler consistency condition. (auth)

49478 PARAMETERS OF THE $A_1 \to \rho\pi$ DECAY. Zovko, N. (Rudjer Boskovic Inst., Zagreb). Nucl. Phys.; B18: 215-20(1970).

Combining the superconvergent sum rules for the $A_1\rho \to A_1\rho$ amplitude with the current algebraic "hard-pion" calculations of the related vertices given by Schnitzer and Weinberg, the solution $\delta = 0$ was found, implying a purely S-wave $A_1 \to \rho\pi$ decay. The closely connected $\pi_N\rho A_1$ and $A_1\rho A_1$ couplings were also calculated in this model. Predictions of the adopted "saturation hypothesis" are compared with other theoretical results and available experimental data. (auth)

49479 PREDICTIONS OF MULTI-REGGE MODELS FOR THE ANTIPROTON–PROTON ANNIHILATION TO FOUR CHARGED PIONS. Frodesen, A. G.; Skjeggestad, O.; Saetre, P. (Univ. of Oslo). Nucl. Phys.; B18: 45-60(1970).

The predictions of the multi-Regge model of Chan, Loskiewicz and Allison (CLA) and of two modified versions by Plahte and Roberts and by Roberts have been examined by comparison with observations for the annihilation channel $\bar{p} + p \to 2\pi^+ + 2\pi^-$ at 1.2, 3.3 and 5.7 GeV/c incoming antiproton momentum. The CLA model is found to give a good description of various single-particle distributions, such as c.m. angles and longitudinal and transverse momenta. The Roberts model also provides a fair account of all single-particle distributions, whereas the Plahte-Roberts model is less successful. In its original form the CLA model does not incorporate resonance formation. The other models, on the other hand, seem to overemphasize two particle resonance production compared to the experimental findings. Attempts to remedy this discrepancy are discussed. The first model gives a correct variation of the cross section with the antiproton momentum, whereas the other models predict cross sections which seem to decrease too fast with the antiproton momentum. (auth)

49480 MULTIPOINT VENEZIANO MODEL, GHOSTS, AND CHIRAL CONSTRAINTS. Waltz, R. E. (Univ. of Chicago). Nucl. Phys.; B18: 61-76(1970).

Veneziano models are constructed for typical five-point spinless (no parity doubling) processes $\pi^+\eta\pi^-\pi^+\pi^-$ (abnormal parity) and $\pi^+\sigma\pi^-\pi^+\pi^-$ (normal parity). They are simple one term crossing symmetric forms with full Regge behavior, no negative mass-squared ghosts, and further they obey soft-pion theorems using realistic trajectory parameters and external masses. The four-point amplitudes implied by the five-point amplitudes are of the Lovelace $\pi^+\pi^-\pi^+\pi^-$ and the Blackman, Goebel and Walt $A^+_{1,2}\pi^-\pi^+\pi^-$ forms. Emphasis is placed on the normal parity process for which it is shown that chiral constraints and the absence of negative mass-squared ghosts suggest a natural form for the amplitude. An implicit πA_1 bootstrap is found and testable predictions on the A_1 decay modes and strengths are made. (auth)

49481 MODEL FOR THE DIFFRACTIVE BACKGROUND OF $\pi\pi$ SCATTERING. Antoniou, N. G.; Widder, F. (Univ., Tuebingen, Ger.). Nucl. Phys.; B18: 85-92(1970).

A model for the diffractive background of $\pi\pi$ scattering is constructed, satisfying analyticity and crossing symmetry. The corresponding amplitude, which represents the exchange of a non-flat Pomeron, gives appreciable contributions to the small s, t and u-region. But it is still possible to fulfill Adler's condition, to obtain the scattering lengths predicted by current algebra, and to saturate the Adler-Weisberger sum rule, when such a term is added to the Veneziano amplitude with the "experimental" ρ-trajectory ($\alpha_\rho(0) = 0.56$). (auth)

49482 FINITE-ENERGY SUM RULES AND THE GENERALIZED INTERFERENCE MODEL. Kellett, B. H. (Univ. of Manchester, Eng.). Nucl. Phys.; B18: 173-81(1970).

The analytic constraints on a general scattering amplitude given by finite-energy sum rules are investigated within the framework of the generalized interference model. The conditions imposed by the requirement that the resonance contributions superconverge for all moments and all values of the momentum transfer are investigated. An approximate solution is given for the particular case of the ρ-trajectory contributions to $\pi\pi$ scattering. (auth)

49483 ZEROS OF CROSSING-EVEN $\pi-\pi$ AMPLITUDES AND THE I = 2 SCATTERING LENGTH. Gensini, P. (Univ., Lecce, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy). Nuovo Cim.; 69A: 529-37(1 Oct 1970).

The analytic structure of the inverse of a crossing-even $\pi-\pi$ elastic-scattering amplitude is studied, and a dispersion relation is written for the inverse of the combination $\frac{1}{2}[A^{\pi^+\pi^+}(\omega) + A^{\pi^+\pi^-}(\omega)]$, which, when required to give an amplitude under threshold consistent with that given by a conventional once-subtracted dispersion relation for the amplitude, gives for the I = 2 S-wave scattering length the value $a_{22} = -0.04 \pm 0.02$. (auth)

49484 NOTE ON THE A_1 AND Q-DECAYS. Griffiths, David (Wayne State Univ., Detroit). Nucl. Phys.; B18: 24-8(1970).

The distribution of events on the Dalitz plot for the decay of boson resonances into three pseudoscalar mesons has been described by both partial-wave analysis and the use of phenomenological tensor couplings. It is shown that the relation between these approaches is not as simple as had been previously assumed. A technique for relating the two approaches is demonstrated and the results are given for 1^+ and 2^- decays. (auth)

49485 DUAL-SYMMETRIC THEORY OF HADRONS. I. Susskind, L. (Yeshiva Univ., New York). Nuovo Cim.; 69A: 457-96(1 Oct 1970).

A theory of mesons is based on the experimentally observed linear level spacing of hadron excitations. The theory uses a model for the internal structure of mesons consisting of a system of harmonic vibrations. Roughly speaking, a meson is described by the degrees of freedom of a four-dimensional rubber band with a quark pair embedded in it. The theory satisfies relativistic invariance, crossing symmetry and a generalization of duality which we call dual-symmetry. In the approximation of retaining only tree graphs, the scattering amplitudes are given by the n-point dual amplitudes recently proposed by Virasoro, Bardakci and Ruegg, Chan and Goebel and Sakita. In the special case, n = 4, the Veneziano formula is reproduced. (auth)

49486 FIXED-ANGLE AMPLITUDES, THRESHOLD BEHAVIOR, AND N/D EQUATIONS. Majumdar, Rabi; Varma, V. S. (Univ. of Delhi, India). Nucl. Phys.; B16: 364-8(1970).

Using fixed-angle amplitudes and the proper threshold and asymptotic conditions within the framework of the N/D formalism, the self-consistency of numerical solutions for the ρ-meson parameters in $\pi\pi$ scattering is investigated. The results obtained are unsatisfactory, showing yet again that a one-channel unitary calculation of the ρ-meson, with no CDD poles, does not work. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 49327, 49330, 49346, 49606, and 49938.

49487 (COO-264-555) ATTEMPT AT A REGGE POLE–REGGE CUT DESCRIPTION OF HIGH ENERGY πN SCATTERING. Ferber, Alan C. (Chicago Univ., Ill. Enrico Fermi Inst. Chicago Univ., Ill. Dept of Physics). [1970]. Contract AT(11-1)-264. 13p. (EFI-70-42). Dep. CFSTI.

An attempt is made to fit near forward differential and the full known range of total πN cross sections by a Regge pole-Regge cut model. Possible explanations for the failure of this are discussed. (auth)

49488 (NP-18417) DUAL STRUCTURE IN πN SCATTERING. Kawaguchi, Norio (Osaka Univ. (Japan)). Aug 1970. 18p. Dep. CFSTI (U. S. Sales Only).

The modified finite-energy sum rule, which is applicable to general amplitudes including the Veneziano-type amplitude, is derived and discussed. New structures of the dual amplitude for the πN charge-exchange process are also discussed. From these structures and the modified FESR one gets $\alpha_\rho = 0.43 \pm 0.12$ for the intercept of the ρ trajectory. (auth)

49489 (SINP-TH-68-2) PCAC CONSISTENCY CONDITION AND ρ-MESON CONTRIBUTION IN S-WAVE FOR ON-SHELL π-N SCATTERING. Banerjee, Haridas; Mallik, Samir (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). [nd]. 11p. Dep. CFSTI (U. S. Sales Only).

Assuming unsubtracted backward dispersion relations for physical πN scattering, one can obtain the PCAC consistency condition and relate the contributions from the ρ-meson to S-wave scattering lengths with those from the dominant P-wave singularities. The on-shell derivation emphasizes the analogy between the PCAC consistency condition and the Goldberger-Treiman relation. (auth)

49490 (SINP-TH-69-6) STRIP UNITARIZATION AND THE VENEZIANO MODEL FOR PION–NUCLEON SCATTERING. Roy, S.; Dasgupta, P. (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). [1968]. 12p. Dep. CFSTI (U. S. Sales Only).

There are difficulties of extrapolating to the low-energy region the Veneziano-type amplitude without secondary terms. It is suggested that the low energy scattering may be obtained by unitarizing the leading Veneziano term within a low-energy strip. (auth)

49491 (UCRL-19774) THE REACTION $K^+N \rightarrow K^*N$ IN THE ISOSPIN-0 CHANNEL NEAR THRESHOLD. Hirata, A. A.; Goldhaber, G.; Seeger, V. H.; Trilling, G. H.; Wohl, C. G. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr 1970. Contract W-7405-eng-48. 6p. (CONF-700416-8). Dep. CFSTI.

From International Conference on Hyperon Resonances, Durham, N. C.

A discussion of the isospin-0 $K^+ + N \rightarrow K + N + \pi$ channel is presented based on $K^+ + d$ data. The results show that above the K^*N threshold, at 1.080 GeV/c, most of the $I = 0$ $K\pi N$ production proceeds via the K^*N channel. The K^* production and decay angular distributions indicate the presence of several partial waves even near threshold and suggest that the main production mechanism is t-channel pion exchange. The energy dependence of the cross sections and the production and decay angular distributions are discussed. (J.F.P.)

49492 MODIFIED VENEZIANO MODEL FOR πN SCATTERING. Miyata, Yasunori (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto); 43: 1013-20(Apr 1970).

A method is proposed for modification of the usual Veneziano model. This method is based on the fact that only to satisfy the high energy behavior, the nonleading terms can be added to the usual Veneziano amplitudes. This modified amplitude for pion-nucleon scattering is shown to give a reasonable approximation to nature with regard to low energies, as well as the forward and backward scattering at high energies. (auth)

49493 REGGE POLE MODEL WITH FLAT ($\alpha(t) = 0$) TRAJECTORIES. Senju, Hirofumi; Suzuki, Tsuneo (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 976-85(Apr 1970).

A possible existence of flat trajectories with $\alpha(t) = 0$ is examined. The s^{-2} dependence of the differential cross section and the asymmetry ratio of the polarized photon experiment in $\gamma p \rightarrow \pi^0 p$ are both satisfactorily explained. The difficulties pointed out by Harari on the basis of the vector meson dominance are also solved. Differential cross sections and polarizations of $\pi^- p \rightarrow \eta n$ and $\pi^- p \rightarrow \pi^0 n$ are well fitted up to large $|t|$ by introducing the flat trajectories in addition to the linear A_1 or ρ trajectory. (auth)

49494 COUPLING REGULARITY OF THE $N^*-N-\pi$ INTERACTIONS. Kaiba, Masayuki (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 1107-9(Apr 1970).

It is shown that the dimensionless coupling constants of the $N^*N\pi$ interactions exhibit a remarkable regularity, when the effective interaction Hamiltonian is written down under suitable principles. (L.B.S.)

49495 DIP-BUMP STRUCTURE OF CROSS SECTION AND URBARYON REARRANGEMENT. Imachi, Masahiro; Otsuki, Shoichiro; Toyoda, Fumihiko (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 43: 1105-7(Apr 1970).

A possible connection between the dip-bump structure of $d\sigma/dt$ and phenomenological regularities of resonances in the H-type amplitude of urbaryon rearrangement is examined. The spin-flip amplitude for πN scattering is discussed for illustration. (L.B.S.)

49496 HIGH-ENERGY PION–NUCLEON SCATTERING DATA AND THE POMERANCHUK THEOREM. Wit, R. (CERN, Geneva). Nuovo Cim.; 69A: 312-20(21 Sep 1970).

The high-energy data for the π^+-N forward scattering are analyzed in connection with the possible violation of the Pomeranchuk theorem. No strong evidence for such a violation is found; the importance of further, precise measurements of Re T^+ is emphasized. (auth)

49497 EFFECTIVE LAGRANGIANS IN PION-PRODUCTION PROCESS $\pi N \rightarrow 2\pi N$. Murtaza, Ghulam; Harun-Ar-Rashid, A. M. (Univ. of Islamabad, Rawalpindi, Pakistan). Ann. Phys. (N. Y.); 59: 426-43(Aug 1970).

Chiral dynamics is applied to study the pion-production process $\pi N \rightarrow 2\pi N$ and comparison is made with the results of current algebra. The isobar production process $\pi N \rightarrow \pi N^*(1236)$ is also examined and the production parameters are determined. (auth)

49498 SPIN–ISOSPIN INTERCHANGE IN YUKAWA INTERACTIONS. Wentzel, G. (Univ. of Chicago). pp 228-31 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

The construction of "dual" models theories through the interchange of spin and isospin (charge) quantum numbers is discussed. A novel application, involving strong coupling approximation, is outlined. This would predict the existence of a vector K meson with isospin $\frac{1}{2}$. (auth)

49499 DISCREPANCY BETWEEN SOFT-PION PREDICTIONS AND EXPERIMENT IN $NN \rightarrow NN\pi$. Schillaci, M. E.; Silbar, R. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., D; 2: 1220-5(1 Oct 1970).

Sources of a discrepancy between experiment and model-independent soft-pion predictions for the production of low-energy pions in the reaction $pp \rightarrow np\pi^+$ at 740 MeV are examined and discussed. These predictions deal only with the leading behavior of the production amplitude. However, higher-order terms, present because $\mu \neq 0$, seem to dominate because of resonance effects. An extended version of the Mandelstam resonance model appears sufficient to explain the experimental data, even for the lowest-energy pions. Ambiguities in pion production at threshold are also discussed. (auth)

49500 STUDY OF $K-N$ ($\bar{K}-N$) SCATTERING BASED ON THE NEW INTERFERENCE MODEL. Karasuno, Toshiaki; Minami, Shigeo (Osaka City Univ.). Phys. Rev., D; 2: 1320-6 (1 Oct 1970).

$K-N$ ($\bar{K}-N$) elastic scattering is described by the new interference model in which the scattering amplitude consists of the direct-channel resonance amplitude and the Regge amplitude without the signature factor. The requirement of duality is taken into consideration. The existence of the exotic resonance Z^* is discussed, and its effects on K^+-p scattering are examined. (auth)

49501 PSEUDOSCALAR-MESON–NUCLEON SCATTERING AND REGGE CUTS. Roth, T.; Renninger, G. H. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 2: 1293-1300(1 Oct 1970).

A simultaneous fit to the data on the four charge-exchange reactions $\pi^- p \rightarrow \pi^0 n$, $K^- p \rightarrow \bar{K}^0 n$, $K^+ n \rightarrow K^0 p$, and $\pi^- p \rightarrow \eta n$ is made, using a Regge-pole model modified by the inclusion of the lowest-order Regge cuts produced, by means of the impact-parameter representation. (auth)

49502 REGGE MODEL FOR $Y_1^*(1385)$-PRODUCTION REACTIONS. Renninger, G. H. (Carnegie-Mellon Univ., Pittsburgh. Inst. for Advanced Study, Princeton, N. J.); Sarma, K. V. L. Phys. Rev., D; 2: 1281-5(1 Oct 1970).

A model is constructed for the analysis of the reactions $K^- p \rightarrow \pi^- Y_1^{*+}(1385)$ and $\pi^+ p \rightarrow K^+ Y_1^{*+}(1385)$ in terms of the exchanges of two Regge trajectories [the $K^*(892)$ and $K^{**}(1420)$]. The present model is a natural extension of the one which has been successful in the description of the $\Delta(1238)$-production reactions. (auth)

49503 STUDY OF THE $K\pi\pi$ SYSTEM IN $K^- p \rightarrow K^- \pi^+ \pi^- p$ AT 12.6 GeV/c. Ludlam, T.; Sandweiss, J., Slaughter, A. J. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., D; 2: 1234-44(1 Oct 1970).

The $K\pi\pi$ spectrum in the reaction $K^- p \rightarrow K^- \pi^+ \pi^- p$ at 12.6 GeV/c is analyzed, taking as a starting point the observation that the transverse momentum distributions are uniform throughout this spectrum and are restricted to small values. This behavior results in a threshold enhancement in the $K\pi\pi$ spectrum corresponding to every $K\pi$ mass value. With the exception of the Q peak, and perhaps the L meson, the $K\pi\pi$ mass spectrum can be regarded as a continuous sequence of such enhancements, which follow from phase-space distributions in the longitudinal momenta. A double-Regge-pole-exchange model for the Q gives qualitative agreement with the data, but only if at least two exchange amplitudes are included; it does not give a correct description of the detailed correlations between the longitudinal and transverse momenta. A more successful description is given by a very simple resonance model. The similarities between the predictions of these two models—which are related by the concept of duality—are discussed in terms of the kinematic restrictions imposed by the condition of small transverse moments. (auth)

49504 PION–NUCLEON SCATTERING AND PRODUCTION IN THE D_{13} STATE. Miller, Arthur I.; Lomon, Earle L. (Massachusetts Inst. of Tech, Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 2: 1245-67(1 Oct 1970).

A model of the coupled πN, ρN, σN, and $\pi\Delta$ channels is adjusted to the πN scattering and pion production data below 700-MeV pion laboratory kinetic energy. A very good description is obtained of the complex D_{13} amplitude below 700 MeV, simultaneously with

a good fit to the structural details of pion production in the 400 to 700-MeV energy interval. In computing the pion production distributions, the only addition made to the D_{13} contribution is a phase-space background accounting for 20 to 50% of the production cross section. The maximal interference effects between decaying resonances are investigated. Also reported are attempts to fit the data without the σN channel, but with the ωN or higher threshold channels. The cross sections for ρ, Δ, or ω production predicted at 1.0 to 1.5 BeV are consistent with the higher-energy data: Too much σ production is predicted. (auth)

49505 COMMENTS ON BARYONIC STATES. Feynman, R. P. (California Inst. of Tech., Pasadena); Pakvasa, S.; Tuan, S. F. Phys. Rev., D; 2: 1267-70(1 Oct 1970).

Some regularities in the baryon mass spectrum and possible experimental verification of them are discussed. (auth)

49506 DIPS ASSOCIATED WITH THE A_2 TRAJECTORY. Bander, Myron; Gotsman, E. (Univ. of California, Irvine). Phys. Rev., D; 2: 1345-6(1 Oct 1970).

Arguments are presented indicating that the $p\Delta A_2$ vertex is primarily spin flip. Using this information, predictions of various cut models for dips at $t = -0.6$ GeV^2 are compared with experiment. (auth)

49507 FIRST PHASE-BAND DESCRIPTION: π^+–p SCATTERING AT 2.50 AND 2.75 BeV/c. Bridges, David (Univ. of Oregon, Eugene); Moravcsik, Michael J.; Yokosawa, Akihiko. Phys. Rev. Lett.; 25: 770-3(14 Sep 1970).

The first phase-band analysis of actual data is reported. Good solutions are obtained for π^+–p scattering at considerably higher energies than conventional phase shifts have reached. (auth)

49508 STUDY OF THE REACTION $\pi^+p \to \Sigma^+K^+$ AT 1.7 GeV/c. Pan, Yu-li; Forman, Fred L. (Univ. of Pennsylvania, Philadelphia). Nucl. Phys.; B16: 61-8(1970).

Data on the reaction $\pi^+p \to \Sigma^+K^+$ at 1.7 GeV/c are presented. The cross section for this channel is 0.47 ± 0.04 mb. The results were compared with various theoretical models. In addition, a possible violation of charge independence is found in the backward direction. (auth)

49509 ETA PRODUCTION BY PIONS. Carreras, B. (Daresbury Nuclear Physics Lab., Eng.); Donnachie, A. Nucl. Phys.; B16: 35-45(1970).

The generalized interference model is applied to the process of eta production by pions. The model is shown to give a good description of this process at all energies. (auth)

49510 $\bar{K}^-p$ AND $\bar{p}p$ ELASTIC SCATTERING AND THE SHADOW OF GENERALIZED ANNIHILATION PROCESSES. Henzi, R. (Univ. of California, Los Angeles); Kotanski, A.; Morgan, D.; Van Hove, L. Nucl. Phys.; B16: 1-34(1970).

The differences between the high-energy total cross sections and elastic scatterings of $\bar{K}^-p$ and $\bar{p}p$ and their counterparts under crossing, K^+p or pp, are analysed in terms of the inelastic channels open for the former and closed for the latter system. For $\bar{p}p$ these channels are mainly baryon annihilation. For $\bar{K}^-p$ the concept of hypercharge annihilation $\bar{K}^-p \to$ hypercharge-zero particles (mainly one $Y = 0$ hyperon and $Y = 0$ mesons) and a vaguer notion of charge annihilation are introduced, and it is proposed that these generalized annihilation channels are the main ones open to $\bar{K}^-p$ and closed to K^+p. The contribution of the generalized annihilation processes to the overlap function of the overall collision is derived from the σ_T and $d\sigma_{el}/dt$ data, using various simple model assumptions. The results, which are insensitive to the latter, predict the total annihilation cross sections and their high-energy dependence, as well as the range of the annihilation processes. The annihilation cross sections compare well with the few measured values. The annihilation ranges are predicted to be equal for $\bar{K}^-p$ and $\bar{p}p$, with a value close to the range of elastic scattering of $\bar{p}p$ and pp. The elastic range of Kp is smaller by about a factor of two. (auth)

49511 PARTIAL WIDTHS FOR THE DECAY OF $T = \frac{1}{2}$ NUCLEON STATES INTO Σ^+K^+. Feuerbacher, J. L.; Holladay, W. G. (Vanderbilt Univ., Nashville). Nucl. Phys.; B16: 85-92 (1970).

Reduced partial widths, partial widths, and branching fractions for the decay of $T = \frac{1}{2}$ nucleon resonances into Σ^+K^+ were determined by fitting differential cross section and average polarization data between threshold and 2 GeV c.m. energy in the process $\pi^+p \to \Sigma^+K^+$. Resonance contributions were taken to have the Breit–Wigner form and pole terms in the crossed channels were used to represent the non-resonant background. The resonances $S_{31}(1635)$, $P_{31}(1934)$, $P_{33}(1236)$, $P_{33}(1688)$, $D_{33}(1691)$, $D_{35}(1954)$, $F_{35}(1913)$ and $F_{37}(1946)$ were included in the model. Fits to the data are obtained by varying the pole and resonance strengths. The partial width of the $F_{37}(1946)$ into the ΣK channel is compared with values calculated by several models. (auth)

49512 DOUBLE-PERIPHERAL MODEL AND THE FOUR-MOMENTUM-TRANSFER DISTRIBUTIONS IN THE REACTION $K^+p \to K^+\pi^-N^{*++}$ AT 5 GeV/c INCOMING MOMENTUM. Bialas, A. (CERN, Geneva); Bassompierre, G.; Eskreys, A.; (and others). Nucl. Phys.; B16: 178-90(1970).

The reaction $K^+p \to K^+\pi^-N^{*++}$ was analyzed at 5 GeV/c K^+ primary momentum, from the point of view of the double-peripheral model. The distributions of four-momentum transfers t'_{pN^*} and t'_{KK} ($t' = t - t_{min}$) were studied as functions of the masses of the $N^{*++}\pi^-$ and $K^+\pi^-$ systems. It is found that the observed correlations cannot be explained adequately by the present version of the Chan–Łoskiewicz–Allison model. The disagreement is particularly striking for the low $N^{*++}\pi^-$ mass region, where the data show peripheral production of the N^{*++}, contrary to the prediction of the model. The implications of the results for the double peripheral model are discussed. (auth)

49513 VENEZIANO FORMULATION OF PION–NUCLEON SCATTERING. Hendry, A. W.; Jones, S. T.; Wyld, H. W. Jr. (Univ. of Illinois, Urbana). Nucl. Phys.; B15: 389-96(1970).

Igi's extension of Veneziano's model to pion-nucleon charge-exchange scattering is examined. It is found that it is possible to obtain a good fit to the forward scattering data, but both forward and backward directions could not be fitted simultaneously. The uniqueness of the formulas is discussed. (auth)

49514 N, Δ, AND ρ-EXCHANGE IN PION-NUCLEON SCATTERING. Engels, J. (Univ., Karlsruhe, Ger.); Hoehler, G.; Petersson, B. Nucl. Phys.; B15: 365-88(1970).

The N, Δ and ρ-exchange contributions to the πN charge exchange amplitude as derived from fixed-t and fixed angle $\theta = 180°$ dispersion relations are compared with the corresponding terms in a chiral Lagrangian. A new evaluation of the backward dispersion relation combined with the forward dispersion relation gives information on the physical origin and the magnitude of the corrections to the simple ρ-dominance and N, Δ, ρ-exchange models. The result for the $\pi N\Delta$-coupling constant $g^{*2}/4\pi = 0.26$ differs from that of other authors and the determination of the ρNN coupling constants leads to difficulties which were ignored in earlier work. The equality between the forward and backward amplitudes at threshold gives a relation between coupling constants similar to a result which was recently derived from chiral Lagrangians. (auth)

49515 CALCULATION OF pi–N TOTAL CROSS-SECTION AT HIGH ENERGY LIMIT. Sekine, Matsuo (Tokyo Inst. of Tech.). Soryushiron Kenkyu; 40: 147-50(Dec 1969). (In Japanese).

The total cross section of $\pi + N$ scattering is discussed. The cross section is constant and approximately 24 mb at 30 GeV or over in the recent $\pi^4 + p$ experiment at Serpukhov. This value is explained by a dispersion formula with good convergence characteristics. (J.F.P.)

49516 Ω^- AS A $K\Xi$ BOUND STATE IN BROKEN SU(3) YUKAWA-TYPE LAGRANGIAN FIELD THEORY. Redei, L. B. (Umea Univ., Sweden). Nucl. Phys.; B17: 38-44(1970).

In a previous article the mass of the $N^*_\frac{3}{2}$ resonance was calculated by assuming pseudoscalar Yukawa coupling and summing those terms in the perturbation expansion of the S-matrix which do not contain more than two mesons and a nucleon in their intermediate state. Fitting the pion–nucleon coupling constant to the scattering length $g^2/4\pi = 23.25$, $M_{N^*} = 1368$ MeV was obtained. Low energy $K\Xi$ scattering is treated by the same method. Yukawa coupling is assumed between the octet baryons and the pseudoscalar octet mesons and SU(3) relations for the coupling constants while using the physical values for the masses. The experimental value $\alpha = 0.75$ is used for the F/D mixing parameter and $g^2/4\pi = 23.25$ is used for the pion–nucleon coupling constant as obtained previously by fitting the model to the pion–nucleon scattering length. There are no additional parameters. The Ω^- is obtained as a $K\Xi$ bound state with $M_{\Omega^-} = 1796$ MeV to be compared with experimental value of 1675 MeV. (auth)

49517 CHIRAL DYNAMICS CALCULATIONS OF SINGLE PION PRODUCTION IN PION–NUCLEON INELASTIC SCATTERING. Long, William Frederick. East Lansing, Mich.; Michigan State Univ. (1969. 151p. University Microfilms Order No. 70-9589.

Thesis

The current algebra program initiated by Murray Gell–Mann has been incorporated in dynamical models by several people. Weinberg and Schwinger, among others, have constructed so-

called "chiral dynamics" Lagrangians which describe the interaction between nucleons and "soft" pions. A common difficulty of these formulations is an ambiguity in the pi–pi interaction. The most straightforward way of eliminating this ambiguity would be measurement of pi–pi scattering lengths, but that is a very difficult experiment. Olsson and Turner have attempted to resolve the difficulty by calculating the threshold cross section for the process $\pi^- p \to \pi^+ \pi^- n$ in which process the disputed pi–pi interaction strongly contributes. But near threshold the breaking of isospin symmetry is reflected in large differences in phase space volumes, depending on which mass of the supposedly degenerated isomultiplets is used. For this reason, it is desirable to extend the cross section calculation off threshold to where the isospin symmetry incorporated in the model is a more realistic approximation and conclusions about the validity of different models can be based on a larger set of experimental data. Furthermore, such a calculation would give some idea of the maximum energies for which the model, derived for soft pions, could be applied. The calculation was done for five different charge channels retaining all Feynman diagrams and computing the integrals necessary to obtain total and differential cross sections by means of a Monte Carlo method to within four percent. The results indicate that the best fit to low energy total cross sections was given by a model in which chiral symmetry was broken by a term which transforms as a rank two chiral tensor. For incident pion energies much greater than 300 MeV none of the chiral dynamics models employed fit the total cross sections well. Comparatively little relevant data exist for differential cross sections, but what there is indicates poor agreement between experiment and chiral dynamics predictions. (Diss. Abstr.)

49518 NUCLEON AXIAL VECTOR FORM FACTOR AND $SO_{4,2}$ GROUP. Kyriakopoulos, E. (Democritos Nuclear Research Center, Athens). Lett. Nuovo Cim.; 4: 281-4(15 Aug 1970).

The double-pole form of the nucleon axial-vector form factor $G_A(t)$ is obtained. (L.B.S.)

49519 BROKEN SU(3) SUM RULES INVOLVING THE BARYON RESONANCES WITH $J = 1/2$, $J = 3/2$, AND $J = 5/2$. Fourez, G. (Univ. of Maryland, College Park). Nucl. Phys.; B18: 189-210 (1970).

By using an asymptotic symmetry for the SU(3) raising and lowering operator and a chiral SU(3) ⊗ SU(3) algebra, the effects of SU(3) symmetry breaking are investigated for the decay of the resonances $J^P = 1/2^+, 3/2^+, 5/2^+, 1/2^-$ into, respectively, baryons $J^P = 1/2^+, 1/2^-, 3/2^+, 1/2^+$ and a pion. Sum rules involving the physical masses of the particles of the $1/2^\pm$ octet and the $3/2^\pm$ decuplet and their decay coupling constants are derived. The correction to the decay amplitudes due to the breaking of SU(3) symmetry is found to be of the order of only a few percent if there is no particle mixing. Comparison with experiments (when available) is carried out. For the $3/2^+ \to 1/2^+ + 0^-$ decays the correction is in the right direction to improve the discrepancy between the present experimental data and the prediction of exact SU(3) symmetry. However it is not enough to remove the entire discrepancy which seems to indicate the necessity of introducing some mixing effect. The sum rule for the decay $1/2 \to 3/2 + 0^-$ shows that the F-wave decay is negligible compared to the P-wave decay. The Gursey-Radicati type intermultiplet mass formulas for the $1/2$ octet and $3/2$ decuplet are deduced from current algebra and the $(1/2^+)$ Ξ particle is predicted to have a mass around 2.030 MeV. This value is consistent with the value obtained from the Gell-Mann/Okubo formula and agrees well with the mass of recently found Ξ (2030). (auth)

49520 S-CHANNEL HELICITY CONSERVATION, FIXED POLES, AND DIP MECHANISMS. Jones, H. F. (Imperial Coll. of Science and Tech., London). Lett. Nuovo Cim.; 4: 545-8 (19 Sep 1970).

Accepting the hypothesis of s-channel helicity conservation/flip, an inquiry is made into the nature of the t-channel Regge couplings implied thereby. It is found that the form of the requisite couplings has implications for the existence of fixed poles at nonsense, wrong-signature points and hence for the choice of possible dip mechanisms at those points. (J.F.P.)

49521 RISING REGGE TRAJECTORIES IN POTENTIAL SCATTERING. Aly, H. H. (Southern Illinois Univ., Edwardsville); Mueller, H. J. W. Lett. Nuovo Cim.; 4: 675-9(3 Oct 1970).

Explicit expansions available for Regge trajectories in potential theory are used to examine their behavior for energy-dependent coupling constants and range parameters. It is found that if the trajectories are to be linear in s or $s^{\frac{1}{2}}$ then a Yukawa-type potential requires a coupling constant proportional to $s^{\frac{1}{2}}$ or s together with some or no energy dependence of its range, whereas a Gauss-type potential requires a coupling constant proportional to s^2 with no additional energy dependence of its range. The scattering of two particles such as the pion and nucleon is considered. (J.F.P.)

49522 DOUBLE REGGE POLE MODEL FOR THE REACTION $\pi^- p \to p\pi^+\pi^-\pi^-$ AT 13 AND 20 GeV/c. Brandenburg, G. W.; Brenner, A. E.; Ioffredo, M. L.; (and others) (Harvard Univ., Cambridge, Mass.). Nucl. Phys.; B16: 369-88(1970).

Data from the reaction $\pi^- p \to p\pi^+\pi^-\pi^-$ at 13 and 20 GeV/c are used in a comparison of the channel $\pi^- p \to p\rho^0\pi^-$ with a double-Regge-pole model (DRPM) which includes both π- and ρ-trajectory exchanges. A similar comparison is made for the channel $\pi^- p \to pf^0\pi^-$. Excellent agreement between the model and the data is obtained. (auth)

49523 K-MATRIX ANALYSIS OF THE LOW-ENERGY DATA FOR $K^- p$ AND $K_2^0 p$ REACTIONS. Martin, A. D.; Ross, G. G. (Univ. of Durham, Eng.). Nucl. Phys.; B16: 479-502(1970).

A nine-parameter zero-range K-matrix S-wave fit is made to the available experimental data for $\bar{K}^- p$ and $K_2^0 p$ reactions below 280 MeV/c. A unique solution is obtained and compared with the effective-range solution obtained by Kim. It is found that both solutions give good agreement with the data for processes involving only the $\bar{K}N$ and $\Sigma\pi$ channels, but that for processes involving the $\Lambda\pi$ channel the present fit improves on the effective-range fit over the momentum range 0 to 280 MeV/c. The scattering lengths corresponding to the K-matrix solution are given and compared with those obtained in previous analyses. The K-matrix solution is used to compute the unphysical region contribution to KN forward dispersion relations and the AKN and ΣKN coupling constants are calculated. In addition a multichannel analysis of the $\bar{K}^- p$ and $K_2^0 p$ data below 400 MeV/c is performed with the inclusion of $\bar{K}N$ isospin one P-wave amplitudes. In the region up to 400 MeV/c the $P_{1/2}$ and $P_{3/2}$ waves are found to be equally important. Argand plots of the various $\bar{K}N$ partial-wave amplitudes are given. (auth)

49524 PARTIAL WAVE AMPLITUDES FOR $\pi^+ p$ ELASTIC SCATTERING IN THE 2 TO 5 GeV/c REGION. Roychoudhury, R. K.; Perrin, R.; Branaden, B. H. (Univ. of Durham, Eng.). Nucl. Phys.; B16: 461-78(1970).

The experimental $\pi^+ p$ elastic scattering data in the momentum region 2 to 5 GeV/c was fitted by a model in which the amplitudes are represented as the sum of Regge-pole exchange terms and parametric terms based on polynominal expansions in $\cos\theta$. Phase shift parameters are subsequently obtained by a partial wave projection. The phase shifts obtained are then examined for resonant structure. (auth)

49525 ON A POSSIBLE A_2' REGGE POLE. De Brion, J. P.; Derem, A. (CEN, Saclay, France). Nucl. Phys.; B16: 511-22 (1970).

In the charge-exchange reactions $\pi^- p \to \pi^0 n$, $\pi^- p \to \eta^0 n$ and $K^- p \to \bar{K}^0 n$, the hypothesis is made that the amplitude is a sum of Regge poles only. Then, besides the ρ′ pole in the first reaction, an A_2' pole accompanying the A_2 pole in the two other reactions is introduced. Solutions are obtained where the trajectory $\alpha_{A2'}(t)$ is linear with t and passes through $J = 2$ at $t = m^2_{A2'}$. The trajectory $\alpha_{A2'}(t)$ could be associated with the $I = 1$ member of a 0^+ octet, located at $t \approx \text{GeV}^2$. (auth)

49526 IN SEARCH OF EXOTIC STATES. Jacob, M.; Weyers, J. (CERN, Geneva). Nuovo Cim.; 69A: 521-8(1 Oct 1970).

It is argued that if exotic mesons exist at all, backward scattering is the most favorable reaction to search for them. In particular, for exotics with masses around (1.5 to 2) GeV, their backward production in π- or K-nucleon collisions is expected to be comparable to the one observed for vector or tensor mesons. (auth)

49527 SOME REMARKS FOR π–$\mathcal{N}$ SCATTERING TOWARDS NEARLY CONSTANT BOUNDS FOR HIGH-ENERGY TOTAL CROSS-SECTIONS AND THE POMERANCHUK THEOREM. Cornille, H. (Institut de Physique Nucleaire, Orsay, France). Nuovo Cim.; 69A, 345-74(1 Oct 1970).

Some rigorous results of local field theory suggest further restrictive assumptions about the crossing symmetric and antisymmetric parts of the π–$\mathcal{N}$ scattering amplitude in so far as their high-energy, small-momentum-transfer behavior is concerned, thus ensuring the existence of some weighted averages of both the real and imaginary parts in each case. One finds first that the total cross-sections $\sigma_T^{\pi^+}$ (or $\sigma_T^{\pi^-}$) cannot saturate high-energy bounds of the type $(\log s)^p$, $(\log\log s)^\epsilon$, $[\log(\log\ldots\log s)\ldots]^p$, p integer, $\epsilon > 0$, and secondly for the Pomeranchuk theorem considered in some average sense one obtains that $(\sigma_T^{\pi^+} - \sigma_T^{\pi^-})/s[\log(\log\ldots\log s)\ldots]^p$ is integrable when s goes to infinity. These results are respectively obtained from the study of the

symmetric and the antisymmetric parts of the amplitude. If these results are not satisfied there exists within our framework two possibilities. On one hand the amplitudes could be indefinitely oscillating. If not, there would appear, for the symmetric amplitude or for the antisymmetric amplitude, particular zeros in linear combinations of the real and imaginary parts of these amplitudes. These zeros would always be present in the nearly forward asymptotic domain with energy as large and transfer as small as one wants. (auth)

49528 NEW FORMULATION OF CONTINUOUS-MOMENT SUM RULES APPLIED TO FORWARD PION–NUCLEON SCATTERING. Ferrari, E.; Violini, G. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cim.; 69A: 375-411(1 Oct 1970).

It is discussed in detail how it is possible to derive continuous-moment sum rules in a consistent way; the connection between these sum rules and the finite-energy sum rules is also explicitly shown. The sum rules are applied to the analysis of forward πA scattering. Particular attention is devoted to the problem of correctly handling the experimental errors, in order to understand the true predictive capacity of continuous-moment sum rules. From the analysis of the crossing-odd amplitude it is suggested that the usual Regge-pole expansion provides a better approximation for the scattering amplitude stripped of the Born term than for the full amplitude. The results are consistent with a ρ-exchange model; it is shown that realistic errors on the ρ parameters are much larger than usually claimed. In the crossing-even case serious inconsistencies arise from the assumption of a simple Regge-pole model. (auth)

49529 VENEZIANO MODEL FOR THE SCATTERING OF MESON AND BARYON SUPERMULTIPLETS. Delbourgo, R.; Rotelli, P. (Imperial Coll. of Science and Tech., London). Nuovo Cim.; 69A: 412-18(1 Oct 1970).

An adaptation of the multispinor formalism for evaluating duality diagrams is applied to the scattering of mesons (6,6) from baryons (56,1). The prescription automatically provides the "correct" D/F ratios and relative magnitudes of helicity flip/no flip amplitudes at the particle poles, and reproduces Reggeized supermultiplet predictions in the asymptotic region. However, the resonance structure is highly unphysical and consequently the low-energy predictions are very poor. (auth)

49530 INTERFERENCE OF t AND u CHANNEL AMPLITUDES IN PION NUCLEON SCATTERING. Auvil, P. R.; Halzen, F.; Margolis, B. (CERN, Geneva). Phys. Lett.; 32B: 709-11(14 Sep 1970).

A Regge model is proposed for the full angular distribution in πN scattering. The pronounced dip near $t = -2.8$ (GeV/c)^2 is explained as a t-u channel exchange interference effect. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 49773.

49531 (ORO-3765-27) PION PRODUCTION AND THE TWO-NUCLEON INTERACTION. Technical Report No. 71-008. Zollman, Dean (Maryland Univ., College Park. Dept. of Physics and Astronomy). Jul 1970. 32p. Dep. CFSTI.

The distorted-wave Born approximation, justified in a previous study, is applied to π^0 production in proton–proton collisions. The production amplitude is studied as a function of the phenomenological two-nucleon potential used to describe the proton–proton interaction. For selected possible experiments it is shown that the pion production amplitude depends on which phenomenological potential is used to describe the two-nucleon interaction. (auth)

49532 π DIFFRACTION DISSOCIATION FROM NUCLEI AND THE A_1 RESONANCE. Hoang, T. F. (Argonne National Lab., Ill.). Nuovo Cim.; 69A: 327-43(21 Sep 1970).

An independent-particle model was used within the framework of Glauber's theory to describe the π diffraction dissociation from nuclei. An analysis of the experimental data on $\pi^- \to \pi\rho$ of the Orsay–Milan–Saclay and Berkeley collaboration was carried out in terms of this model. The main purpose is to investigate the nature of the A_1 enhancement. The following two hypotheses have been considered: I) A_1 as a $\pi\rho$ resonance and II) A_1 as a system of two uncorrelated particles π and ρ. The results of the present analysis favor the hypothesis of a $\pi\rho$ resonance and indicate $\sigma_{A_1 N} \approx \sigma\pi N$. A crucial test for the nature of A_1 was proposed on the basis of the nuclear-absorption effect. The method can also be applied for the identification of the Q-meson. (auth)

49533 ABSORPTIVE VENEZIANO MODEL FOR NN AND $\bar{N}N$ SCATTERING. Roberts, R. G. (Univ. of California, San Diego, La Jolla). Nuovo Cim.; 69A: 321-6(21 Sep 1970).

The NN system is described by Veneziano formulas consistent with crossing and Regge behavior. The amplitudes are unitarized according to Lovelace's K-matrix procedure. Absorption corrections due to competing channels provide a natural way of including diffraction scattering. (auth)

49534 EIKONAL MODEL FOR HIGH-ENERGY p–p SCATTERING AT LARGE ANGLES. Gaisser, T. K. (Cambridge Univ., Eng.). Phys. Rev., D; 2: 1337-41(1 Oct 1970).

A simplified form of a relativistic generalization of the eikonal approximation for wide-angle potential scattering provides a semiquantitative description of p-p scattering at large energy and momentum transfer over a variation of more than five orders of magnitude in $d\sigma/dt$. The model contains two adjustable parameters. (auth)

49535 LACK OF A BURNETT–KROLL THEOREM FOR SOFT-PION EMISSION. Silbar, R. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., D; 2: 1350-1(1 Oct 1970).

It is shown that, in the context of the reaction $NN \to NN\pi$, when more than one nucleon pole graph contributes, the soft-pion analog of the Burnett–Kroll extension of the Low soft-photon theorem cannot be established. (auth)

49536 p–p SCATTERING AT VERY HIGH ENERGY AND MASSIVE ELECTRODYNAMICS. Yao, York-peng (Univ. of Michigan, Ann Arbor). Phys. Rev., D; 2: 1342-4(1 Oct 1970).

A formula derived recently in massive electrodynamics is applied to p-p scattering. The $C = +1$ amplitude due to ω exchange gives rather interesting predictions at very high energy. The total cross section is found to be 31 to 32 mb; $\sigma_{el} \approx 4.5$ mb. (auth)

49537 REGGE POLES AND THE PAULI PRINCIPLE. Huang, Kerson; Paige, Frank E. (Massachusesst Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 2: 1351-2(1 Oct 1970).

In a Regge-pole model of large-angle pp scattering, Huang and Pinsky take the Pauli principle into account by adding t- and u-channel Regge poles. It is pointed out that this procedure is consistent with the finite-energy sum rules. In a recent note, Pinsky points out some regularities in the experimental data and contends that they favor a different model in dealing with the Pauli principle, namely, some kind of "duality" between the t and u channels. It is shown that the regularities he noticed are also reproduced by the original "additive" model. (auth)

49538 ANGULAR DISTRIBUTION OF MULTIPARTICLE EVENTS AT HIGH ENERGY. Caneschi, L. (Univ. of California, Santa Barbara); Lyon, D. E. Jr.; Risk, Clifford. Phys. Rev. Lett.; 25: 774-6(14 Sep 1970).

Angular distributions of charged secondaries in pp interactions for the energy range 100 to 800 GeV are compared with the predictions of the d^3p/E distribution. (auth)

49539 MULTICHANNEL APPROACH TO HIGH-ENERGY REACTIONS BY THE ONE-BOSON-EXCHANGE MODEL. Hiroshige, Noboru; Watari, Wataro (Osaka City Univ.). Progr. Theor. Phys. (Kyoto); 43: 1560-73(Jun 1970).

A simple multi-channel model of p–p scattering at high energy which is based on the one-boson-exchange model is investigated. It is shown that the shape of the absorption parameter in the large impact parameter region is mainly governed by the mass of the exchanged boson. From the comparison with the results of Higuchi and Machida, it is suggested that the absorption in this large impact parameter region is predominantly originated by the pion exchange mechanism. The experimentally observed approximate energy independence of the absorption parameter and shrinking phenomena in p–p scattering are discussed in connection with the effects of opening of new inelastic channels. (auth)

49540 INTERACTION OF HADRONS WITH DEUTERONS AT HIGH ENERGIES, INELASTIC PROCESSES, AND DUALITY. Kancheli, O. V.; Matinyan, S. G. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.); 12: 30-4(5 Jul 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 41-4 (5 Jul 1970).

The energy behavior of the screening correction to the total cross section for the interaction between a high-energy pion with a deuteron is traced with allowance for the inelastic processes. (J.F.P.)

49541 PRODUCTION CHARACTERISTICS OF THE REACTION $pp \to pn\pi^+$ AT 7 GeV/c. Lyons, L. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys.; B15: 355-64(1970).

The peripheral features of the reaction $pp \to pn\pi^+$ at 7 GeV/c are investigated. Especially those distributions which are sensi-

tive to the model are compared with the predictions of a double-Regge-exchange mechanism. The observed Treiman–Yang distributions are qualitatively consistent with the relevant exchanges being the pion and Pomeron trajectories. (auth)

49542 ELASTIC SCATTERING OF LOW-ENERGY PIONS BY ALPHA PARTICLES. Harun-Ar Rashid, A. M.; Samaranayake, V. K. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys.: B17: 189-205(1970).

The low-energy pion–alpha-particle elastic scattering is investigated using Schwinger's variational expression for the T-matrix. The method allows us to evaluate double scattering effects in a simple way. The results of the calculation are compared with the available experimental data. (auth)

49543 EFFECT OF AN TENSOR FORCE ON THE LAMBDA-PARTICLE BINDING IN NUCLEAR MATTER. Goodfellow, J. F.; Nogami, Y. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; B18: 182-8(1970).

The effect of the AN tensor force on the binding energy of a Λ-particle in infinite nuclear matter is estimated by using separable potentials which permit exact solutions of the Bethe–Goldstone equation. For the same strength of the tensor force the binding energy suppression increases with increasing range. For reasonable values of the range and strength, however, the amount of suppression is found to be less than 1 MeV. (auth)

49544 QUARK MODEL PREDICTIONS FOR THE DECAY DISTRIBUTIONS OF RESONANCES PRODUCED IN THE REACTION $\frac{1}{2}^+\frac{1}{2}^+ \rightarrow \frac{3}{2}^+\frac{3}{2}^+$. Rudnicka, Hanna (Inst. of Nuclear Techniques, Krakow). Nucl. Phys.; B18: 135-40(1970).

Quark-model predictions for reactions BB → B*B* with polarized initial baryons are given. The joint decay distributions of pairs of resonances B* produced in this reaction are described by statistical tensors. (auth)

49545 N/D UNITARY ISOBAR MODEL OF NN → NN*. Bruno, Daniel R. O.; Duck, Ian M. (Rice Univ., Houston, Tex.). Nucl. Phys.; B16: 399-415(1970).

The effect of the complex singularity of the NN → NN* OPE production amplitude on NN elastic scattering amplitudes is determined in an extended N/D method due to Ball–Frazer–Nauenberg and Cook–Lee. Calculations are reported for S-wave interactions, no spin or isospin for a variety of interaction strengths and resonance widths. Comparisons are made with the usual N/D and determinantal methods. (auth)

49546 RELATION BETWEEN THE TOTAL CROSS SECTION AND THE SLOPE OF $\ln(d\sigma/dt)$ IN THE HIGH-ENERGY SCATTERING. Sawada, T. (Univ. of Oregon, Eugene). Phys. Lett.; 32B: 700-2(14 Sep 1970).

From the unitarity condition a sum rule $s^{-1}\int_T A(s,t)dt = +1$ is derived for p-p scattering amplitude. A relation between σ_{tot} and the slope of $\ln(d\sigma/dt)$ is obtained and compared with experiment. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 49617 and 49618.

49547 SU_3 STRUCTURE OF THE INELASTIC SHADOW IN A VENEZIANO MODEL FOR A NONET OF STABLE PARTICLES. Baacke, J. (CERN, Geneva). Nuovo Cim.; 69A: 297-311(21 Sep 1970).

In the framework of a model for the Veneziano n-point function in a world with an SU_3 nonet of stable particles proposed by Paton and Chan the SU_3 structure of the inelastic shadow is investigated in the ladder approximation. The inelastic shadow is found to transform asymptotically as an SU_3 singlet with degenerate couplings to the octet and singlet particles; the asymptotic limit is well approximated already at low intermediate-particle multiplicities. Also the SU_3 structure in the case of symmetry breaking is investigated and it is found that the inelastic shadow acquires an octet component independently of the structure of the input symmetry breaking. (auth)

49548 ZERO-ENERGY BOUND STATES OF TWO DIRAC PARTICLES. ON THE PROPERTIES OF EIGENVALUE SPECTRA OF THE O(4) FAMILIES. Ito, Hitoshi (Kinki Univ., Osaka). Progr. Theor. Phys. (Kyoto); 43: 1035-49 (Apr 1970).

Zero-energy bound states of two equal-mass Dirac particles, including particle-particle and particle-antiparticle systems, are classified into eight O(4) families, four of which are peculiar to the off-shell amplitude (they do not appear as the poles of the on-shell scattering amplitude). The properties of eigenvalue spectrum of each family are examined by using the Bethe–Salpeter equation. The ladder approximation of the scalar, pseudo-scalar, vector and axial-vector meson exchange is assumed there. It is shown that the equations for the families peculiar to the off-shell amplitude are reduced to the Goldstein-type ones and therefore these families have only the continuous spectrum. They may be regarded as unphysical for kinematical reason. The discrete spectra are found in the remaining four families. (auth)

49549 FORMAL THEORY OF NONLINEAR REALIZATION OF A GROUP ON ITS SUBGROUP. Okabayashi, Takao; Watanabe, Tadashi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 1085-1104(Apr 1970).

Groups with a sub-group are classified from the point of view of the theory of nonlinear realization of a group G on its sub-group H. Starting from Lie's differential equations, a general prescription is developed for the realization by taking two typical cases; the one is the case of a self-conjugate preferred (or boost) field and the other a conjugate pair of preferred fields case. It is shown that the realization is possible only if the homogeneous space G/H is symmetric. The formulation and almost all the results are completely general and the properties of individual groups are confined to some constants which appear in several identities on the generators and structure constants of the sub-group. The theory is applied to the groups SU(2) × SU(2) and SU(3). (auth)

49550 RELATION OF THE INHOMOGENEOUS DE SITTER GROUP TO THE QUANTUM MECHANICS OF ELEMENTARY PARTICLES. Aghassi, J. J.; Roman, P.; Santilli, R. M. (Boston Univ.). J. Math. Phys. (N. Y.); 11: 2297-2301(Aug 1970).

A relativistic dynamical group recently introduced by Aghassi, Roman, and Santilli for the quantum mechanics of elementary particles is briefly reviewed. It is shown in detail that the algebra of this group can be obtained by contracting the Lie algebra of the inhomogeneous de Sitter group ISO(3, 2). Some crucial concepts of the proposed new group are shown to appear in a new light when viewed in the context of a de Sitter world. The emergence of proper time as an additional kinematical variable is discussed in some detail. (auth)

49551 NEW THEOREMS ABOUT SPHERICAL HARMONIC EXPANSIONS AND SU(2). Beers, Brian Lee; Dragt, Alex J. (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.); 11: 2313-28(Aug 1970).

Despite the heroic efforts of Laplace, Legendre, Maxwell, Hobson, and company, there are still new chapters to be written in the theory of spherical harmonics. Some of the special windfalls that result when one expands analytic functions are described. In technical language, one is concerned with Fourier series of analytic functions on SU(2). (auth)

49552 PROBLEM OF DISCRETE OPERATIONS. Werle, J. (Univ. of Warsaw). pp 54-60 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

A discussion of the possibility that the rigorous representative of the geometrical space inversion exists and has the form P_q = CPA is given. It is shown that the factors C, P, and possibly A, may depend on time in such a way that they are conserved in the generalized sense and leave the product CPA independent of time and commuting with H. The existence of such a factor A may be possible only for some restricted forms of the interaction Hamiltonian. (auth)

49553 POINCARÉ GROUP AND THE A-REPRESENTATION. Brasthen, Hans J. (Case Western Univ., Cleveland). Contract AT(11-1)-1573. Nucl. Phys.; B15: 477-500(1970).

A basis where one has tried to take into account the special azimuthal symmetry in scattering experiments, and which is of importance in crossing symmetry, is defined. The basis is chosen such that the energy, the third components of the momentum and the angular momentum are diagonal together with the helicity. The Poincaré algebra is represented in this basis. A particular spin algebra, defined in a previous article is utilized in the construction of the representation. The discrete elements of the Poincaré group are also represented. The basis is very well suited for discussing the singularities which come from the definition of the helicity itself. The connection between our basis and that defined by Jacob and Wick is given. The zero-mass case is discussed and it is proven that in our representation the discrete case of zero mass is identical with the limit of the continuous positive-mass case. (auth)

49554 REALIZATIONS OF LIE ALGEBRAS WITH PARA-FIELD OPERATORS. Kademova, K. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys.; B15: 350-4(1970).

A realization of any Lie algebra is given in terms of second-order polynomials of Green-algebra generators. An example of the realization of some class of representations of the Lie algebra in a suitably chosen linear space is also given. (auth)

49555 SCHWINGER TERMS AND SYMMETRY BREAKING. Barnes, K. J.; Isham, C. J. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B17: 267-76(1970).

By considering the transformation properties of Schwinger terms under the action of chiral SU(3) × SU(3), a natural form of symmetry breaking for current theories is proposed and found to have reasonable properties. A full model comprised solely of currents and Schwinger terms (and which is free from parity doubling) is exhibited, and its interpretation discussed. (auth)

49556 PHYSICAL SYMMETRIES AND THE GENERALIZED CARRUTHERS THEOREM. Jancewicz, B.; Lopuszanski, J. T.; Nikolova, L. (Univ., Wroclaw). Nucl. Phys.; B16: 508-10 (1970).

It is shown that in a theory of several scalar, real, local fields forming an irreducible set, local with respect to each other and transforming according to the same representation of the Poincare group with a mass gap, each abstract "physical" symmetry group implemented unitarily has an n-dimensional representation which can be made real by applying a suitable unitary transformation, as a corollary follows the Carruthers theorem for boson fields. For the case of SU(3) only 1, 8, 27 etc., dimensional representations can occur. For the case of 2n real fields a subgroup of SO(2n) with respect to which the fields split into two pair-conjugate multiplets can be used. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 49407, 49423, and 49428.

49557 (COO-264-548) REMARKS ON THE BETA DECAY OF HYPERONS. Oehme, Reinhard; Winston, Roland; Garcia, Augusto (Chicago Univ., Ill. Enrico Fermi Inst. Chicago Univ., Ill. Dept. of Physics). Aug 1970. Contracts AT(11-1)-264; AT(11-1)-1701. 14p. (COO-1701-11; EFI-70-31). Dep. CFSTI.

The formulas for spin and angular correlations in hyperon β-decay are brought into forms which can give specific information about the character of possible deviations from the universal SU(3) scheme. The usefulness of the proposed combinations is discussed qualitatively. (auth)

49558 SU(3) ⊗ SU(3), SYMMETRY BREAKING, AND CABIBBO ANGLE. Bane, J. C.; Mahanthappa, K. T. (Univ. of Colorado, Boulder). Contract AF-AFOSR-30-67. Phys. Rev. Lett.; 25: 779-81(14 Sep 1970).

Making use of bootstrap equations for symmetry-breaking vectors in $(3^*, 3) \oplus (\bar{3}, \bar{3}^*)$ and $(1, 8) \oplus (8, 1)$ representations of SU(3) ⊗ SU(3) with both octet and 27-plet electromagnetic and weak driving terms, and requiring partial conservation of vector current and the Cabibbo angle $\theta_c \neq 0$, a solution of the form of Gell-Mann, Oakes, and Renner for semistrong breaking interaction is obtained. Knowing the deviation from SU(2) ⊗ SU(2) in their work, one obtains $\theta_c \approx 0.22$. The nonleptonic $\Delta S = 1$ interaction cannot be rotated away as it is in $(1, 8) \oplus (8, 1)$. Also the electromagnetic tadpole cannot be in $(3^*, \bar{3}) \oplus (\bar{3}, 3^*)$ but can be in $(1, 8) \oplus (8, 1)$. (auth)

49559 C-VIOLATION IN η-DECAY. Frenkel, A. (Central Research Inst. of Physics, Budapest); Vesztergombi, G.; Marx, G. Nucl. Phys.; B15: 429-41(1970).

The recent experimental results on the charge asymmetry in η-decay were compared with a theoretical model of C-violation. Five asymmetry parameters of the $\eta \rightarrow \pi^+\pi^0\pi^-$ energy distribution were defined and their measured values were reproduced by the model within one standard deviation. The implication of the experimental upper limit on the $\eta \rightarrow \pi^0 e^+ e^-$ decay was also taken into account. Order of magnitude estimates indicate that the model is not in contradiction with the experimental results on the K_L decay. (auth)

49560 POSSIBLE ORIGINS OF INTERNAL SYMMETRY. Penney, Robert V. (Ford Motor Co., Dearborn, Mich.). Amer. J. Phys.; 38: 1307-9(Nov 1970).

It is argued that the existence of the Pauli and Touschek transformations for the four-component neutrino field is a simple consequence of the fact that the basic wave function is a direct sum of two elementary spinors. (auth)

Applications (Strong)

Refer also to abstracts 49348 and 49443.

49561 (DEMO-70/14) INFINITE MULTIPLETS WITH SU(3). Kyriakopoulos, E. (Democritus Nuclear Research Center, Athens (Greece)). May 1970. 23p. Dep. CFSTI (U. S. Sales Only).

An infinite multiplet model for mesons containing SU(3) was constructed. The model is based on the mapping of the group $SU(3)/Z_3$ into SO(8), and on the fact that the n-dimensional spherical harmonics can be accommodated into a single irreducible representation of the group SO(n,2). In this relativistic SU(6) type scheme only SU(3) representations of triality zero appear. An infinite component wave equation is given with mass spectrum

$$m^2 = \frac{\beta}{a}\left(t + \frac{n-2}{2}\right)^2 + \frac{\xi}{a} J(J+1) + \frac{1}{a}\left\{b + cY + d\left[I(I+1) - \frac{Y^2}{4}\right]\right\}$$

The form factors fall off rapidly with t. (auth)

49562 PROJECTION FORMULA FOR O(2,1)-INVARIANT OFF-SHELL FUNCTIONS. Ferrara, S. (CNEN, Frascati, Italy); Mattioli, G. Ann. Phys. (N. Y.); 59: 444-55(Aug 1970).

Projection formulas, which allow a generalized Laplace transform for a class of O(2,1)-invariant off-shell functions, are derived in a rigorous way. The usefulness of this transformation for the physical case of the two spinless particle scattering amplitudes at fixed space-like momentum transfer described by ladder graphs is shown. (auth)

49563 YANG-MILLS GAUGE THEORY OF SUPERMULTIPLETS. Delbourgo, R. (Imperial Coll. of Science and Tech., London); Salam, Abdus; Strathdee, J. pp 247-56 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

The problem of constructing U (3) Yang-Mills type of phenomenological Langrangians is considered for hadrons. Instead of starting from a Dirac free Langrangian for spin-half nucleons or from one of the many available Lagrangians for spin-three-half particles, one accepts the basically composite symmetric three-quark structure of baryons, and expressing this compositeness field theoretically by considering a U (12) multi-spinor formalism, gauge this hadron Lagrangian using the standard Yang-Mills replacement: $\partial_\mu \rightarrow \partial_\mu - igV_\mu$. The resulting effective Yang-Mills interaction (somewhat surprisingly) turns out to be the vector-meson-baryon interaction of the U (12) theory; in particular one correctly recovers the SU (6) results like a nonzero magnetic moment μ_n for the neutron and the ratio $\mu_p/\mu_n = -3/2$. The proton magnetic moment in absolute value is predicted wrongly at this state and still has the Dirac value $\mu_p = 1$. It is shown that the "correct" value $\mu_p = -3/2\ \mu_n = 1 + 2\ m/\mu$ may be obtained if the tensor and pion interactions are now introduced by extending the Yang-Mills substitution to a U (12) substitution: $i\gamma\partial \rightarrow i\gamma\partial + \Sigma_R \gamma_R \varphi_R$. This essentially (though not exactly) reproduces the successful full three-point U (12) couplings among supermultiplets guaranteeing in addition a universality of all coupling constraints. The use of the starting free Lagrangian is essential, other equivalent free Lagrangians not manifestly symmetric but possessing the content of the free U (12) equations of motion do not give correct results when the minimal Yang-Mills principle is applied to them. It is believed therefore that the free SU (3) invariant Lagrangian advocated is the one appropriate for construction of phenomenological interaction Lagrangians of Yang-Mills or (chiral) nonlinear variety. (auth)

49564 PSEUDOSCALAR MESONS IN BROKEN CHIRAL SYMMETRY: η-x^0 MIXING. Pande, L. K. (Univ. of Texas, Austin). Contract AT(40-1)-3992. Phys. Rev. Lett.; 25: 777-9(14 Sep 1970).

The x^0 mass as well as the η-x^0 mixing angle are predicted using the broken chiral symmetry scheme. The basic input in the calculation is the Goldstone character of some of the pseudoscalar mesons in certain symmetry limits. (auth)

49565 ALTERNATIVE TO QUARKS. Hillion, P. (Institut Henri Poincare, Paris). Nuovo Cim.; 69A: 508-30(1 Oct 1970).

The existence of projective realizations of the irreducible unitary representations of SU_3/Z_3 is proved in the Hilbert space of functions $f(\alpha,\Sigma)$ on C^2, square integrable for a convenient measure $\nu(\alpha)$. These realisations supply the usual results of the eightfold way without a priori introduction of the Nishijima-Gell-Mann formula and of the experimental results $\pm Y = 2I$, $\pm Y = 2I - 2$. Then it is given a physical interpretation with C^2 identified with the Stokes parameter space, which explains why isospin formalism has no meaning for leptons and photons. Further on it is shown that, in this formalism, the invariance of strong interactions only

under two U_2 particular symmetries in C^2 supplies the same results and does not require any broken symmetry. (auth)

Field Theories

General

49566 TOPOLOGICAL ANALYSIS OF A NONLINEAR FIELD THEORY. Williams, J. G. (Univ. of Alberta, Edmonton). J. Math. Phys. (N. Y.); 11: 2611-16(Aug 1970).

A class of nonlinear field theories that exhibit conserved particlelike structures is considered. An example of such a theory is quoted. Fields belonging to this theory are classical fields, single-valued under the action of the rotation group. It is explained how, when the theory is quantized, the quantum mechanical states which correspond to 1-particle systems in the unquantized theory may have properties similar to fermion states. In particular, it is shown that it is possible for wavefunctionals to exist which are double-valued under 2π rotations. This is the first known example in which a single-valued field theory can give rise to a quantized theory with half-odd spin properties. (auth)

Quantum Field Theory

Refer also to abstracts 49460 and 49616.

49567 (IFPTH-7/70) EQUAL TIME COMMUTATORS FROM BROKEN CONFORMAL INVARIANCE AND IMPLICATIONS FOR ASYMPTOTIC SUM RULES. Ciccariello, S.; Gatto, R.; Sartori, G.; Tonin, M. (Padua Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Padua (Italy)). [1970]. 83p. Dep. CFSTI (U. S. Sales Only).

A nonlagrangian field theory is developed, extending some ideas by Wilson. The theory is based on simultaneously broken conformal invariance and chiral U(3) ⊕ U(3). The local operators of lowest dimension are assumed to be: the chiral current j_μ^α transforming under U(3) ⊕ U(3) as $(1,0,-1)(0,0,0) \oplus (0,0,0)(1,0,-1)$ plus two singlet components; the fields $u^\alpha(x)$ transforming as $(1+s,s,s)$ $(-s,-s,-1-s) \oplus (-s,-s,-1-s)(1+s,s,s)$; two fields w^R belonging to $(s',s',s')(-s',-s',-s') \oplus (-s',-s',-s')(s',s',s')$; the traceless part of $\theta_{\mu\nu}$. Furthermore $\theta_{\mu\mu} - \epsilon^\alpha u^\alpha - \epsilon^A w^A$ commutes with all U(3) ⊕ U(3) generators. In the limit $\epsilon \to 0$ (skeleton theory) one assumes U(3) ⊕ U(3) invariance and conformal invariance, with definite tensor properties of the above operators under conformal transformations. Systematic use of the invariance properties allows for a calculation of all the equal time commutators among the currents, $\theta_{\mu\nu}$, and the densities u^α and w^R in terms of some parameters. Applications of the theory to asymptotic electroproduction and neutrino production sum rules are considered. In particular neutrino-production sum rules are determined from electroproduction sum rules. When a plausible assumption is introduced for the behavior of the longitudinal scale function at $\omega = 0$, one finds that all asymptotic sum rules depend only on one parameter. (auth)

49568 (IS-T-392) A QUANTUM ELECTRODYNAMICS FOR VECTOR MESONS. Tucker, Robert Henry (Ames Lab., Iowa). Sep 1970. Contract W-7405-eng-82. 98p. Dep. CFSTI.

Thesis.

A quantum electrodynamics for vector mesons is constructed in which the vector meson is described by a six-component column matrix satisfying a single equation of motion with no auxiliary conditions. The S-matrix is derived directly from Green function solutions of the equations of motion rather than from Dyson's equation to avoid an interaction Hamiltonian which contains an infinite number of surface terms. In the reduction of the S-matrix terms appear which do not correspond to Feynman-type terms but which vanish if only regularized integrals are used. The Feynman rules are then identical in form to the rules for scalar electrodynamics. A distinct calculational advantage of this theory is that all components of Fock-space operators are treated on equal footing and create and destroy particles in definite energy and polarization states. Trace theorems for the covariantly defined spin-one matrices are given to further facilitate calculations. The theory is found to be nonrenormalizable. The results are extended to equations for particles with arbitrary mass and spin. (auth)

49569 (LAL-1235) MEASUREMENT OF THE CROSS SECTION FOR ELECTRON-POSITRON SCATTERING AT HIGH ENERGY AND THE VALIDITY OF QUANTUM ELECTRODYNAMICS. Lelanne, Dominique (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Jun 1970. 150p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

This experiment is one of the most exact tests of quantum electrodynamic theory. The absolute cross section of the $e^+e^- \to e^+e^-$ reaction was determined from a number of elastic scattering events. This measurement necessitated the exact determination of the luminosity of the Orsay storage ring. This was achieved by detecting the gamma ray photons emitted in the double bremsstrahlung reaction: $e^+e^- \to e^+e^-\gamma\gamma$. The mechanisms involved in the operation of the lead scintillator sandwich counters were described in detail. The analysis of the elastic electron positron scattering events necessitated a thorough study of all the possible causes of systematic and statistical errors. An accuracy of approximately two percent was obtained for the cross sections. A comparison with theoretical results gave the limit of the validity of quantum electrodynamics. The lower limit for the cut off parameter Λ obtained was Λ > 2 GeV. (France)

49570 (RT/FI-(70)13) TACHYONS: POSSIBLE PARTICLES WITH GREATER-THAN-LIGHT VELOCITY. Bafico, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 23 Feb 1970. 23p. (In Italian). Dep. CFSTI (U. S. Sales Only).

Various problems raised by the hypothesis of faster than light particles are studied. In particular the causal puzzles are discussed which, at first sight, arise and how to solve them. The difficulties encountered in a field theory for such particles are also discussed. (auth)

49571 THEORY OF FORMAL SERIES WITH APPLICATIONS TO QUANTUM FIELD THEORY. Dubois-Violette, M. (Centre National de la Recherche Scientifique, Marseille). J. Math. Phys. (N. Y.); 11: 2539-46(Aug 1970).

The theory of formal series is developed in such a way that it includes conventional formal series as well as Volterra's series (generating functionals) as special cases. A method for expressing solutions of nonlinear equations is developed. (auth)

49572 BOGOLYUBOV EDGE-OF-THE-WEDGE THEOREM: DEVELOPMENT AND APPLICATION. Vladimirov, V. S. (Inst. of Mathematics, Moscow). pp 61-7 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

Further development generalization and application of the famous Bogolubov theorem in quantum field theory and in other domains of mathematics are given. (auth)

49573 POSITIVITY CONDITION IN MOMENTUM SPACE. Glaser, V. (CERN, Geneva). pp 68-89 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

A formulation of the positivity condition within the framework of the general field theory is given in momentum space. It is shown how the usual requirements of locality and spectrum can be partially incorporated in order to represent the "absorptive parts" of the Green's functions by positive operators of the Hilbert-Schmidt type operating on a suitably defined Hilbert space of analytic functions introduced into mathematics by Bergman and Bochner. The application of this method to the x space positivity condition formulated by Wightman is not discussed. As an illustration, two simple examples are discussed. (auth)

49574 GRADIENT TERMS OF CURRENT COMMUTATORS IN QUANTUM ELECTRODYNAMICS. Kaschluhn, F.; Wieczorek, E.; Zoellner, W. (Humboldt Univ., Berlin. Inst. for High-Energy Physics, Berlin). pp 108-12 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

The singular equal-time behavior of the vacuum expectation value of current commutators is determined in second and fourth-order quantum electrodynamics. It is shown that gradient terms appear which are singular at equal times. Furthermore, the corresponding behavior of the second order T-products of currents is studied with special regard to the quasi-local terms occurring in the standard renormalization prescription. This allows a detailed discussion of the relation between the divergence of T-products and equal-time commutators. In addition the connection between the asymptotic behavior of spectral functions and the equal-time behavior of Wightman functions is elaborated for some important cases. (auth)

49575 RENORMALIZATION OF FIELD OPERATORS. Medvedev, B. V. (Inst. of Mathematics, Moscow); Polivanov, M. K. pp 125-39 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

In classical works on renormalization the problem of renor-

malization of the Heisenberg field operators remains still unsolved. It is found that in order to solve this problem it is necessary to introduce some special rules of calculation which would allow one to answer unambiguously any question concerning the above renormalization. The consideration is performed on the basis of the axiomatic S-matrix theory. (auth)

49576 PROPERTIES OF THE COVARIANT TWO-POINT FUNCTION AND THE VALIDITY OF TCP THEOREM OF INFINITE-COMPONENT FIELDS. Todorov, I. T. pp 168-80 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

This is a survey of the general properties of the two point function which occurs in the theory with infinite-component fields. The discussion is based on recent works by R. P. Zaikov, A. I. Oksak and the author. (auth)

49577 RENORMALIZED HAMILTONIANS FOR A CLASS OF QUANTUM FIELDS WITH INFINITE MASS AND CHARGE RENORMALIZATIONS. Hepp, K. (Institut des Hautes Etudes Scientifiques, Paris). pp 181-94 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

Using techniques developed by J. Glimm the $(P + Q: \bar{\psi}\psi:)$-interaction is studied in two-dimensional space-time (P, Q: Wick-ordered polynomials in a free scalar field, ϕ: a two component spinor field). After a suitable choice of renormalization counter terms the Hamiltonian for a finite region in space-time is proved to exist as a densely defined symmetric operator, which is approximated by ultraviolet cut-off operators in strong convergence in Fork space. (auth)

49578 SCATTERING OPERATOR FOR QUANTUM FIELDS. Hoegh-Krohn, Raphael (Princeton Univ., N. J.). Contract AF 49(638)-1545. Commun. Math. Phys.; 18: 109-26(1970).

Quantum fields interacting by the interactions usually considered in the theory of elementary particles are studied. That is the interaction density is taken to be a polynomial P in the fields, and it is assumed that $P = P_b + P_f + P_w$, where P_b is a fourth-order polynomial in the boson fields only, P_f is linear in the boson fields and P_w is a polynomial in the fermi fields only. After introducing a space and momentum cut-off in the interaction it is proved that the scattering operator exists for all values of the cut-off parameters. The scattering operators of relativistic quantum fields are then introduced as weak limit points of cut-off scattering operators as the cut-off is taken away. (auth)

49579 RENORMALIZATION OF A QUADRATIC INTERACTION IN THE HAMILTONIAN FORMALISM. Ginibre, J. (Faculte des Sciences, Orsay, France); Velo, G. Commun. Math. Phys.; 18: 65-81(1970).

The method of the dressing transformation is used to perform a mass renormalization of a neutral scalar free field in the Hamiltonian formalism, for arbitrary space dimension. The resulting situation is analyzed by means of a Bogoliubov transformation, and seen to yield the expected results. (auth)

49580 GENERALIZED MAJORANA AND NAMBU EQUATIONS WITH ANTIPARTICLES AND REFLECTION PROPERTIES. Miyazaki, Tadashi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 1616-18(Jun 1970).

The Majorana and Nambu equations are generalized to include antiparticles. The operators of space inversion, charge conjugation and time reversal are formulated within the framework of c-number theory. (L.B.S.)

49581 RELATIVISTIC COVARIANCE OF AN INTERACTING QUANTUM FIELD. Cannon, John T.; Jaffe, Arthur M. (Massachusetts Inst. of Tech., Cambridge. Harvard Univ., Cambridge, Mass.). Bull. Amer. Math. Soc.; 76: 853-5(Jul 1970).

The $\lambda(\phi^4)$ quantum field theory model which describes a self-interacting boson field is discussed. It is proven that relativistic covariance of the field under Lorentz transformation holds for the $\lambda(\phi^4)$ model considered. (J.F.P.)

49582 P(ϕ) QUANTUM FIELD THEORY. Rosen, Lon. (New York Univ., N. Y.). Bull. Amer. Math. Soc.; 76: 619-24(Jul 1970).

The field equations for realistic physical models are discussed. The model used is that of a self-interacting boson field in two-dimensional space—time with self-interaction given by an arbitrary semibounded polynomial in the field. (J.F.P.)

49583 NEW FORMULATION OF QUANTUM ELECTRODYNAMICS. Fox, J. R. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B15: 413-28(1970).

The quantized electromagnetic field theory is formulated in terms of tensor potentials. None of the usual difficulties, such as indefinite metric or unphysical particles arises. Gauge considerations do not enter. The compatibility with axiomatic field theory is discussed. The fields interact locally with the electromagnetic current and the resultant quantum electrodynamics reproduces exactly the usual results. A similar solution to the problem of spin-2 graviton theory is indicated. (auth)

49584 COMPUTER TREATMENT OF THE CREATION AND ANNIHILATION OPERATORS OF THE QUANTUM FIELD THEORY. Bourrely, C. (Centre National de la Recherche Scientifique, Marseille) Di Guglielmo, F. Rev. Fr. Inform. Rech. Oper.; No. R-1, 81-93(Jan-Feb 1970). (In French).

The construction of algorithms allowing an automatic treatment by electronic computer, of commutation calculations for polynomials on a tensor product of noncommutative algebras is studied. An important application is the algebra of creation and annihilation operators in quantum field theory; this case is considered in detail, and examples of typical calculations are given. (France)

49585 FIELD DEPENDENCE OF CURRENTS. Choudhury, S. Rai; Tomozawa, Y.; Yao, Y. P. (Univ. of Michigan, Ann Arbor). Nucl. Phys.; B17: 430-44(1970).

Arguments are presented to show that in a theory with spin $\frac{1}{2}$, vector and axial-vector fields, the vector current in general depends upon the axial-vector field also in addition to the dependence on the vector field. The exact dependence is worked out on quite general grounds. It is pointed out, however, that there are inconsistencies in the approach in which use is made of the definition of field dependent current and the usual canonical commutation relations of vector and axial-vector fields. (auth)

49586 OPERATOR DENSITIES, PHYSICAL FIELDS, AND DYNAMICAL REARRANGEMENT OF SYMMETRY. Freundlich, Y.; Lurie, D. (Technion-Israel Inst. of Tech., Haifa). Nucl. Phys.; B18: 141-50(1970).

A greatly simplified method is presented to determine the specific form of operator densities in terms of physical fields. The method is based on the familiar fact that the matrix element of an operator density between physical states may be calculated by coupling the operator density to an external c-number field and evaluating the lowest order transition amplitude induced by the field. This method is applied to the model by Nambu and Jona-Lasinio treated in the pair approximation. (auth)

49587 CONSTRUCTION OF A VECTOR CURRENT WITH A TIME COMPONENT OBEYING THE ALGEBRA OF CURRENTS. I. Fitelson, Michael; Johnson, Rodney (Syracuse Univ., N. Y.). Nucl. Phys.; B18: 151-61(1970).

It is proposed to study the connection between current algebra and rigorous quantum field theory by constructing, in a model field theory, an isovector-vector current whose time components obey the algebra proposed by Gell-Mann. It is hoped to obtain an appropriate model theory by generalizing the $\lambda\phi^4$ theory of Glimm and Jaffe to include isospin. The construction will require the formation of bounded functions of spatially smeared currents operating on Fock space. In this paper it is shown that such bounded functions can be formed by showing that the smeared currents are essentially self-adjoint on an appropriate domain. (auth)

49588 MASS DEPENDENCE ON THE QUANTIZED FIELDS IN QUANTUM ELECTRODYNAMICS. Gonzalez, Jose J. (Univ., Kiel). Nucl. Phys.; B16: 272-86(1970).

It is shown that the mass dependence on quantized fields has always been overlooked when variational principles have been applied. Since the field dependence of the mass was the crucial observation leading to Kramers' renormalization principle it is expected that this inconsistency is related to the well-known convergence difficulties. The implications of the field dependence of the mass in quantum electrodynamics, provided that the Hamiltonian formalism is applicable, are discussed. It is shown that new terms describing weak and strong interactions appear in the field equations. These new terms describe a virtual "structure" of the particles. This virtual structure is neither in contradiction with experimental facts nor does it violate secured theoretical results. Its relation with form factors is discussed. (auth)

49589 VELOCITY-DEPENDENT POTENTIALS IN QUANTUM MECHANICS. Lin, H. E. (Univ. of Prince Edward Island, Can.); Lin, W. C.; Sugano, R. Nucl. Phys.; B16: 431-49 (1970).

Velocity-dependent potentials are investigated in both the Lagrangian and the Hamiltonian formalism in quantum mechanics. In order to achieve a consistent method, a canonical transformation is introduced for the type of Lagrangian $\frac{1}{2}\dot{q}_i g_{ij}(q)\dot{q}_j - V(q)$ where g_{ij} and V are functions of position operators q_i only. It is found that the proper Hamiltonian satisfying the canonical equa-

tion of motion should be $H = p_i\dot{q}_i - \mathcal{L} - Z$ where Z is a function of q_i and is expressed in terms of $g_{ij}(q)$. This formulation was examined by some examples. The Euler–Lagrange equation that is consistent with the canonical equation of motion is derived and it turns out to be in an apparently dissipated form. However, the physical system could be a non-dissipative one. Finally, the Schroedinger equation is investigated according to the above argument. (auth)

Gravitation and General Relativity

49590 MULTIPOLE MOMENTS. II. CURVED SPACE. Geroch, Robert (Syracuse Univ., N. Y.). J. Math. Phys. (N. Y.); 11: 2580-8(Aug 1970).

Multipole moments are defined for static, asymptotically flat, source-free solutions of Einstein's equations. The definition is completely coordinate independent. One takes one of the 3-surfaces V, orthogonal to the timelike Killing vector, and adds to it a single point Λ at infinity. The resulting space inherits a conformal structure from V. The multipole moments of the solution emerge as a collection of totally symmetric, trace-free tensors P, P_a, P_{ab}, ··· at Λ. These tensors are obtained as certain combinations of the derivatives of the norm of the timelike Killing vector. (For static space–times, this norm plays the role of a "Newtonian gravitational potential.") The formalism is shown to yield the usual multipole moments for a solution of Laplace's equation in flat space, the dependence of these moments on the choice of origin being reflected in the conformal behavior of the P's. As an example, the moments of the Weyl solutions are discussed. (auth)

49591 COMPLEX 2-DIMENSIONAL INTERNAL SPACE IN GENERAL RELATIVITY. Oliveira, Colber G. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). J. Math. Phys. (N. Y.); 11: 2440-4(Aug 1970).

A calculus of vectors in 2-dimensional symplectic spaces is developed from the concept of existence of local basis systems. The similarities, as well as the differences, of this calculus with the tetrad formulation of 4-dimensional curved spaces are discussed. The affinity and curvature of the symplectic space are derived and its relation with the affinity and curvature of the usual spinor formalism are given. A system of hybrid geometrical objects displaying a tensor and a spinor index take over the role of the usual Hermitian matrices $\sigma_\mu^{KM}(x)$. (auth)

49592 CURVATURE COLLINEATIONS FOR GRAVITATIONAL pp WAVES. Aichelburg, P. C. (International Centre for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.); 11: 2458-62(Aug 1970).

Vacuum fields which admit a covariant constant vector are investigated in order to find "curvature collineations," i.e., $\pounds R^i_{klj} = 0$. For all discussed types of pp waves it is shown that proper curvature collineations exist. The explicit form of these transformations is stated. (auth)

49593 EQUAL-TIME COMMUTATION RELATIONS AND DIVERGENCE CONDITIONS. Bergstroem, K. (Inst. of Theoretical Physics, Goteborg). J. Math. Phys. (N. Y.); 11: 2489-98(Aug 1970).

The connection between divergence conditions for currents or generalized currents and equal-time commutation relations is investigated in terms of the response of physical systems to external fields. A simple method of constructing physical amplitudes and of obtaining generalized Ward identities and equal-time commutation relations for currents is given. In order to set up this scheme, one has to make an assumption about the response of the physical system to a change of the external parameters and also consider the gradient terms. In this way, one tries to reproduce the current algebra formalism. It is hoped that, when this has been done, it will have been made plausible that a certain representation of the algebra exist. However, the formal reconstruction of the field theory of strong interactions is not discussed in terms of electromagnetic, weak, and gravitational scattering data. The discussion is mostly restricted to finite-dimensional algebras, but a generalization of the method to infinite-dimensional situations is briefly outlined. (auth)

49594 EQUAL-TIME COMMUTATION RELATION FOR THE ENERGY–MOMENTUM TENSOR. Bergstroem, K. (Inst. of Theoretical Physics, Goteborg). J. Math. Phys. (N. Y.); 11: 2498-2501(Aug 1970).

Using a method outlined previously, an equal-time commutation relation for the energy–momentum tensor is derived. No restrictions are made on the external gravitational field $g_{\mu\nu}$ that couples to the energy–momentum tensor. As a special case of the equal-time commutation relation derived, Schwinger's commutation relation for the energy density is obtained. (auth)

49595 THEORY OF PARTICLES WITH VARIABLE MASS. I. FORMALISM. Greenberger, Daniel M. (City Coll., New York). J. Math. Phys. (N. Y.); 11: 2329-40(Aug 1970).

The equivalence principle (through the mechanism of the gravitational red shift) allows one to set up a classical formalism with the proper time as an extra degree of freedom, independent of the coordinate time, and with an immediate physical interpretation. Then proper time and mass occur as conjugate variables in a canonical formalism, leading to a gravitational theory of particles with variable mass. The nonrelativistic theory and a relativistic vector theory of gravity are described as models. The theory is capable of providing a dynamical framework for cosmological models with the creation of matter. Some simple examples are discussed, including the steady-state universe with continuous creation, where the correct relation between the density of matter and the Hubble constant appears automatically, with no free parameters. (auth)

49596 THEORY OF PARTICLES WITH VARIABLE MASS. II. SOME PHYSICAL CONSEQUENCES. Greenberger, Daniel M. (City Coll., New York). J. Math. Phys. (N. Y.); 11: 2341-7(Aug 1970).

A previous formalism, in which mass and proper time are treated as independent dynamical variables in a canonical formalism, is shown to imply certain physical consequences. There will exist a mass vs proper time uncertainty relation; trajectories and proper time will be exactly determinable in an external gravitational field, while mass will be determinable in an external electromagnetic field; and conventional quantum mechanics will imply that equivalence is invalid for low-lying quantum states. This leads to a second possible way to quantize a system in a gravitational field, which introduces a fundamental length. It is shown that it is possible to test for quantum interference effects of gravitational systems with present technology and conventional techniques, using the earth's gravitational field. (auth)

49597 BLOCK DIAGRAMS AND THE EXTENSION OF TIMELIKE TWO-SURFACES. Walker, Martin (Birkbeck Coll., London). J. Math. Phys. (N. Y.); 11: 2280-6(Aug 1970).

The work of Finkelstein, Kruskal, Graves and Brill, Carter, and Boyer and Lindquist on the extension and schematic representation of 2-dimensional metrics is systematized and generalized. As a result, a number of extensions may be found by inspection. Some well-known examples are given, and the technique is applied to the "soluzioni oblique" of Levi–Civita. (auth)

49598 TREDER TETRAD THEORY OF GRAVITATIONAL FIELDS. Kasper, U. (Zentralinstitut fuer Astrophysik, Potsdam, Ger.). Monatsber. Deut. Akad. Wiss. Berlin; 12: 286-96(1970). (In German).

Based on the Treder Tetrad theory, equations are developed for the gravitational field which do not assume a potential-like coupling between materia and tetrad field. Through this treatment, consequences of potential-like coupling can be clearly recognized. Results are compared with those obtained in previous work. (H.B.G.)

49599 MACH PRINCIPLE AND PHYSICAL VACUUM IN GENERAL RELATIVITY. Markov, M. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 26-7 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

A possible interpretation of the reasons for the physical vacuum to be noninvariant under rotations in the general Relativity is suggested. This interpretation is based on the existence of quantum vacuum fluctuations. (auth)

49600 PLANAR WAVES IN THE GENERAL THEORY OF RELATIVITY. Rodichev, V. I.; Dozmorov, I. M. (Moscow Higher Tech. School). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 20-3(1969). (In Russian).

A class of gravitational fields in empty space is studied by the Newman–Penrose method, permitting a normal congruent isotropic geodetic. It is shown with the energy-momentum tensor in tetrad form that if the nondegenerate metrics of such fields depend only on one isotropic coordinate, then the solutions describe flat gravitational waves. (tr-auth)

49601 COMPLETELY COVARIANT INTEGRAL THEORY OF INERTIA AND GRAVITATION AND ITS MACHIAN IMPLICATIONS. Gilman, Robert Campbell. Princeton, N. J.; Princeton Univ. (1969). 107p. University Microfilms Order No. 70-8364. Thesis.

The development of a Machian theory of inertia and gravitation in which the inertial-gravitational field and its source are considered as just two parts of the physically inseparable source-field phenomenon is described. This theory is expressed in terms

of completely covariant Green's function integral equations based on Einstein's field equations without the cosmological constant term. (These integral equations are of the type first proposed by Altshuler and, independently, by Lynden-Bell.) Integral equations are first developed which are formally equivalent to Einstein's field equations, and the conditions under which these equations are the unique integral equivalents of Einstein's field equations are demonstrated. These conditions are completely analogous to the conditions that must be used to demonstrate the uniqueness of the standard Green's function integral formulations for scalar and vector fields. This integral formulation is then used to define the source-free contribution to the inertial-gravitational field, and a theory is constructed that excludes source-free fields. This theory is essentially general relativity supplemented by a boundary condition. A classification scheme is defined for relativistic cosmologies based on both the source-free contribution to the field and the cosmological constant, with Class I containing those cosmologies that are acceptable in our theory. It is found that most cosmologies of the Robertson-Walker type belong to Class I, but Minkowski space, the Schwarzschild, Kerr, and related solutions, all vacuum cosmologies, the Gödel universe, and the homogeneous but anisotropic models of Thorne, Kantowski, and Sachs do not belong to Class I. This integral theory of inertia and gravitation is compared to the Brans-Dicke scalar-tensor theory, and it is found that the integral theory overcomes their objections to Einstein's field equations. It is also shown how Einstein's criterion for a Machian theory, that the inertia of a body should be affected by neighboring masses, can be satisfactorily translated into covariant geometric terms. (Diss. Abstr.)

49602 S-MATRIX FOR THE GRAVITATIONAL FIELD IN A NONLINEAR GAUGE. Maheshwari, A. (Tokyo Univ.). Lett. Nuovo Cim.; 4: 299-302(15 Aug 1970).

A method previously given for constructing the S-matrix for all gauge fields is illustrated for the gravitational field. (L.B.S.)

49603 COMMENT ON THE PLANE SYMMETRIC SOLUTION OF EINSTEIN EQUATIONS. Horsky, J.; Lenc, M. (Faculty of Science, Brno). Czech. J. Phys.; 20: 1053-4(1970).

A mistake in a previous work on plane symmetry in general relativity is pointed out and corrected. (J.F.P.)

49604 SUPERCONDUCTING AND NORMAL METALS IN A TIME-DEPENDENT GRAVITATIONAL FIELD. Papini, G. (European Space Research Inst., Frascati, Italy). Lett. Nuovo Cim.; 4: 663-6(3 Oct 1970).

It is found that time-dependent gravitational fields induce time-dependent electromagnetic fields in superconductors and normal metals. If they vary sinusoidally, the frequency is the same for both fields. The dielectric constants of superconductors and normal metals are also affected by a gravitational field. Superconductors and normal metals are thus considered as devices suitable for transforming gravitational into electromagnetic radiation. (J.F.P.)

Scattering Theory

Refer also to abstracts 49573 and 49967.

49605 REGGE CUTS IN THE KIKKAWA-SAKITA-VIRASORO MODEL. Arai, Masahiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 1002-12(Apr 1970).

An investigation is made of Regge cuts in the framework of the Kikkawa-Sakita-Virasoro theory. By the use of a non-planar diagram with one box, it is shown that there is a certain type of Regge cuts different from the one considered by Kikkawa. This type of Regge cuts is contained in the amplitudes exchanging a Regge trajectory and an elementary particle. At the same time, fixed poles are present at nonsense points. (auth)

49606 MODEL FOR THE SCATTERING AMPLITUDES AND ITS APPLICATION TO $\pi\pi$ AND πN SCATTERING. Sakai, Sunao (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 43: 986-1001 (Apr 1970).

A new model for scattering amplitudes is proposed. This model satisfies the finite energy sum rule, unitarity at threshold, and other desirable physical properties of scattering amplitudes. In this model daughters are also contained and the duality in our sense is related to Regge pole and cut (scattering state) duality, which is different from the conventional duality relating only to Regge poles. The $\pi\pi$ amplitudes are constructed under the condition of exchange degeneracy of α_ρ and α_f. The model gives good results on scattering lengths. Adler's self-consistency condition gives $\alpha_\rho(\mu^2) > \frac{1}{2}$, which is consistent with the experimental results of $\alpha_\rho(0) = 0.57 \pm 0.01$ and is different from Lovelace's results. The high energy amplitudes obey the Gell-Mann mechanism. The πN amplitudes are constructed in the model under the condition of non-exchange degeneracies among α_α, α_δ, and α_γ trajectories. The πN amplitudes satisfy isospin constraints both in low and in high energy regions, and $\Delta\alpha = 2$. Adler's self-consistency relation is approximately satisfied. The determination of free parameters from low energy resonances predicts high energy amplitudes which are consistent with experimental analysis. (auth)

49607 SINGULAR INTEGRAL OPERATOR ENCOUNTERED IN SCATTERING THEORY. Pearson, D. B. (Univ. of Hull, Yorkshire, Eng.). J. Math. Phys. (N. Y.); 11: 2425-31(Aug 1970).

The domain of an unbounded singular integral operator occurring in scattering theory is investigated and is proved to be everywhere dense. An application is made to a simple scattering system, for which the interaction Hamiltonian is of rank one, and the existence of the wave operator is proved by a "time-dependent" method which does not assume "smoothness" of the element of $L_2(-\infty, \infty)$ from which the interaction is constructed. (auth)

49608 DERIVATION OF THE WAVE AND SCATTERING OPERATORS FOR AN INTERACTION OF RANK ONE. Grubb, M. Anthea (Brunel Univ., Middlesex, Eng.); Pearson, D. B. J. Math. Phys. (N. Y.); 11: 2415-24(Aug 1970).

Expressions for the wave and scattering operators in terms of singular integral operators are rigorously derived for a simple scattering system, for which the interaction Hamiltonian V is of rank 1. The wave operators, defined by the strong limits, $\lim e^{iH_1t}e^{-iH_0t}$ as $t \to \mp\infty$, are known to exist for this interaction, and the existence of these limits is assumed throughout. Using complex contour integrals to write down representations for certain operators, an identity is found for the evolution operator in terms of a family of bounded operators, from which singular integral operators are obtained in the limit as $t \to \infty$. The analysis differs from previous applications of time-dependent scattering theory to this system in that at no stage need "smoothness" or Hölder conditions be assumed for the element of $L_2(-\infty, \infty)$ from which V is constructed. (auth)

49609 NEW INTEGRAL FORMULATION OF THE SCHROEDINGER EQUATION. Baird, L. C. (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.); 11: 2235-42(Aug 1970).

The 1-dimensional Schrödinger equation is replaced by a pair of coupled integral equations. The equations are solved by iteration. The zeroth-order solution is the WKB approximation. The solutions are valid even in the presence of classical turning points and discontinuous potentials. Thus, connection formulas are not required. Low-order calculations are carried out in several cases of interest. In each case, a first-order calculation gives results comparable to or better than those obtained with connection formulas. (auth)

49610 O(4) SYMMETRY AND THE BS EQUATION FOR A SPIN-1 + SPIN-0 SYSTEM. Abo-Shaeer, Muhsin A. R. (Univ. of California, Santa Barbara). J. Math. Phys. (N. Y.); 11: 2272-9(Aug 1970).

A set of vector functions analogous to the 3-dimensional vector spherical harmonics is defined in four dimensions. These functions are employed to separate the Bethe-Salpeter (BS) equation for a spin-1 + spin-0 system at vanishing total 4-momentum K, where O(3) symmetry degenerates into O(4) symmetry. The angular parts of the matrix elements of all possible tensor operators, symmetry conserving and otherwise, are reduced. Finally, the BS equation at small K is briefly discussed. (auth)

49611 DISPERSION SUM RULES. Bartl, A. (Univ., Tuebingen, Ger.). Acta Phys. Austr.; 29: 86-90(1969). (In German).

Dispersion sum rules are used to analyze known scattering amplitudes from analytic properties and the high-energy behavior. (L.B.S.)

49612 ABSORPTIVE REGGE CUTS AND LOCAL DUALITY. Holden, J. P.; Thews, R. L. (Univ. of Rochester, N. Y.). Phys. Rev., D; 2: 1332-6(1 Oct 1970).

Local-duality properties of an absorption-model Regge-cut amplitude were investigated in detail. Contrary to previous assertions, it is found that this example does not clarify the question of local duality. First, the structure present in the total cross section does not arise from leading J-plane singularities, and, second, the angular momentum content of the bump structure makes it difficult to associate with resonant behavior. (auth)

49613 NEAR-LOCAL SCATTERING MATRIX. Blokhintsev, D. I.; Kolerov, G. I. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 47-53 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

A possibility of constructing a scattering matrix obeying the unitarity condition and a certain weakened causality condition (macroscopic causality) is considered. (auth)

49614 CAN ONE CONTINUE THE SCATTERING AMPLITUDE THROUGH THE ELASTIC CUT? Martin, Andre (CERN, Geneva). pp 113-24 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

It is shown that two commonly accepted facts are not necessarily true (i) it may be impossible to continue the scattering amplitude through the elastic cut (ii) the correspondence between the analyticity domain of the scattering amplitude and that of the absorptive part in the elastic region may not be the normal one. The supplementary conditions to avoid these parthologies are discussed. (auth)

49615 MONODROMY GROUP OF ONE-LOOP RELATIVISTIC FEYNMAN INTEGRALS. Ponzano, G.; Regge, T. (Inst. for Advanced Study, Princeton, N. J. Istituto di Fisica, Turin). pp 140-67 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969).

The systematic approach of the one-loop Feynmann relativistic amplitude singularities is carried out on the basis of monodromy group of a multivalued analytic function. (auth)

49616 QUASI-POTENTIAL METHOD IN THE RELATIVISTIC TWO-BODY PROBLEM. Kadyshevskii, V. G.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 261-77 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

Basic principles of the quasipotential approach to scattering problems and to the bound states of two particles in relativistic quantum field theory are presented. (auth)

49617 INVARIANCE PROPERTIES OF PROPERTIME FORMULATION OF DUAL RESONANCE MODEL. Miyamoto, Yoneji (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 43: 1620-2(Jun 1970).

A proper time formulation was previously proposed to derive N-body Veneziano formula for $\alpha(0) = 1$. This formulation is generalized to the case $\alpha(0) \neq 1$ by introducing a new freedom of infinite component wave equation in addition to infinite sets of linear oscillators introduced by Nambu, Fubino, and Veneziano to prove the factorization theorem. The invariance properties of the proper time Schroedinger equation under Moebius transformation are also discussed. (L.B.S.)

49618 INFINITE-DIMENSIONAL LIE GROUPS AS SYMMETRIES OF AN S-MATRIX. Westenholz, C. v. (Univ., Muenster, Ger.). Acta Phys. Austr.; 30: 260-70(1969). (In German).

A proof of the following theorem is given: Let $G = \{(a,\Lambda,f) \equiv (a,\Lambda,e)\ (0,I,f);\ f\epsilon D\}$ be an infinite-parameter Lie-group and let G contain as subgroups the group $G_1 = \{(0,I,f)\}$ and a group which is locally isomorphic to the inhomogeneous Lorentz group. Let U(G) be an S-matrix symmetry and let

$$\lim_{t\to\mp\infty} A(f) = A^{out}(f) \equiv A^{ex}(f)$$

be the asymptotic free fields. The spectrum of the energy momentum vector is supposed to be contained in $\{p = 0\} \cup V^+$. The existence of a formal functional relation is assumed between the representation of G_1 and the free fields of the form $U(f) = \phi(A(f))$ which respects the S-matrix symmetry properties. Then $U(G_1)$ is cyclic with respect to the vacuum of the Fock-space. This representation is moreover irreducible in some space $F_0 \subset F$. If $S \epsilon L(F_0,F_0)$ is the restriction of the scattering operator to F_0, it follows: $S = 1$. (auth)

49619 MATHEMATICAL AND PHENOMENOLOGICAL DUALITY. Oehme, R. Nucl. Phys.; B16: 161-77(1970).

The concepts of mathematical and phenomenological duality of binary amplitudes are considered at first in the meromorphic limit. It is shown that mathematical duality is essentially a consequence of the requirement of Regge boundedness of all parts of the amplitude in directions not parallel to the real axes. The role of duality in the presence of unitarity branch lines is discussed and the importance of empty cuts for the construction of interference-type models is emphasized. The approximate expansion of an amplitude into a finite number of pole terms in all channels simultaneously is explored briefly. (auth)

49620 CALCULATING PARTIAL WAVE AMPLITUDES ON THE LEFT-HAND CUT. Petersen, J. Lyng (NORDITA, Copenhagen). Nucl. Phys.; B15: 549-59(1970).

A method is proposed which makes it possible in certain cases to calculate the value of a partial wave amplitude even on those parts of the left-hand cut where standard methods involving crossed-channel partial wave expansions fail for convergence reasons. Certain Regge information about the asymptotic behavior in the crossed channels is required. For the Veneziano model the method becomes a convenient mathematical device by which the asymptotic behavior of partial wave amplitudes may be studied. (auth)

49621 CONNECTION BETWEEN TOLLER AND FROISSART–GRIBOV SIGNATURED AMPLITUDES. Olive, David (Cambridge Univ., Eng.). Nucl. Phys.; B15: 617-27(1970).

Formulas are derived relating the Toller signatured O(2, 1) amplitude to the conventional Froissart-Gribov amplitude and vice versa. This suggests that the amplitudes have equivalent dynamical content. Only equal mass spinless particles are considered; but only rigorous analyticity domains and not necessarily the Mandelstam representation are needed. A vital ingredient of the work is the hermitian analyticity property. (auth)

49622 GENERAL CONTINUOUS-PARAMETER SUM RULES. Garcia, A.; Masperi, L. (CNEA, Bariloche, Argentina). Nucl. Phys.; B15: 560-70(1970).

A class of general finite-energy sum rules not necessarily derived from analyticity and crossing property of the amplitude is discussed. An example is given of a sum rule which has over the continuous-moment sum rules the advantages of a more equilibrated participation of low-energy data and a better separation of two nearby Regge-pole contributions. (auth)

49623 FACTORIZATION AND CYCLIC STRUCTURE IN THE GENERALIZED VENEZIANO MODEL. Montvay, I. (Eoetvoes Univ., Budapest). Nucl. Phys.; B15: 451-60(1970).

In the generalized Veneziano model the particles of negative signature on the leading trajectory cancel as a consequence of the cyclic structure of the amplitude. It is shown that the first-daughter trajectory is non-degenerate for the same reasons. The cyclic structure is relevant also in connection with the factorization, but it turns out that the amplitudes with one excited particle also factorize in all permuted positions. A "direct inspection" proof of Fubini-Veneziano-Ward (FVW) like identities is also included. (auth)

49624 STUDY OF THRESHOLD ZEROS IN THE SOLUTIONS OF THE PARTIAL-WAVE DISPERSION RELATIONS. Nemanic, Edward Bruce. Evanston, Ill.; Northwestern Univ. (1969). 92p. University Microfilms Order 70-6509.

Thesis.

A detailed study was made of the behavior of partial wave amplitudes at threshold. In particular the single particle exchange was examined as an approximate force term in the partial-wave dispersion relations (i.e., the resonance approximation) and the physical meaning of the methods ordinarily used to ensure proper behavior at threshold is indicated. An approximation scheme is proposed which simultaneously generalizes the resonance approximation and ensures correct threshold behavior. When applied to the case of Yukawa potential scattering, this new method yields excellent results which are a considerable improvement over the previous techniques. (TSS) (Diss. Abstr.)

49625 VENEZIANO AMPLITUDE FOR ANY INTERCEPT FROM LOCAL LAGRANGIAN. Kleinert, H. (Freie Univ., Berlin). Lett. Nuovo Cim.; 4: 285-90(15 Aug 1970).

A local Lagrangian is exhibited whose multiperipheral Feynman graphs coincide with the corresponding Veneziano functions and which has the properties that all vertices become constants and the propagator takes a conventional form. In addition, the difficulties associated with using the local conserved current supplied by the Lagrangian to couple the electromagnetic field are discussed. (L.B.S.)

49626 TCP SIGNATURE AND NON-COMPACT COVARIANCE CONDITIONS IN CROSSED PARTIAL WAVE ANALYSIS: THE THREE-REGGEON VERTEX. Goddard, P.; White, A. R. (Cambridge Univ., Eng.). Nucl. Phys.; B17: 45-87(1970).

The incorporation of TCP invariance and the definition of TCP signatured partial wave expansions of multiparticle amplitudes are considered. The partial wave analysis of the six-particle amplitude involving a "three-Reggeon" vertex is studied in detail. Two forms of covariance condition, associated with this vertex, are found to occur. In one case the covariance group is non-compact so that the amplitude can not be square integrable.

The usual theorems do not directly apply. However it is shown that the partial wave coefficients still converge and the expansion theorem holds; the significance of this is examined in detail leading to the full incorporation of the covariance conditions in the partial wave coefficients. The specification of limits in terms of invariants is also considered. (auth)

49627 THREE-REGGEON VERTEX: ANALYTICITY, ASYMPTOTICS, AND THE TOLLER POLE MODEL. Goddard, P.; White, A. R. (Cambridge Univ., Eng.). Nucl. Phys.; B17: 88-116(1970).

The incorporation of the local analyticity properties of the six-particle amplitude in a previous treatment of the three-Reggeon vertex is considered. A triple Regge pole contribution is shown to be singular on the boundary between two parts of the physical region where the partial-wave expansion was shown to take different forms. This singularity can be removed by appropriate behavior of the residue function, but the asymptotic region where the pole contribution can be expected to dominate behaves unsatisfactorily. For comparison, the connection between the singularity of a Regge pole contribution and the bad behavior of the asymptotic region is also discussed for the zero momentum transfer problem. Analytic group variables, uniformly related to the invariants are introduced for the six-particle amplitude. A Lorentz-group expansion incorporating the vertex covariance condition is given and a triple Toller pole shown to be a possible uniform asymptotic approximation to the amplitude in the neighborhood of the boundary considered. The treatment of the three-Reggeon vertex is used to give a full group theoretic treatment of an arbitrary multiparticle amplitude. (auth)

49628 SELF-CONSISTENT REGGE PLANE. Halliday, I. G. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B18: 125-34(1970).

A new multi-peripheral bootstrap equation is presented and discussed. In place of previous assumptions about dominance of leading j-plane singularities all j-singularities are retained. In order to make the equations simple enough to handle it is assumed that the couplings have a simple, no correlation, form. The resulting nonlinear integral equation is nonsingular and after solution the poles, cuts, and their residues and discontinuities may be extracted numerically by continuing the equation. (auth)

49629 GENERALIZED VENEZIANO MODEL. Miranskii, V. A.; Shelest, V. P.; Zinov'ev, G. M. (Inst. for Theoretical Physics, Kiev). Lett. Nuovo Cim.; 4: 659-62(3 Oct 1970).

It is shown that one can construct an amplitude with a finite number of daughter Regge trajectories corresponding to the generalized interference model, but the dual amplitude with a finite number of daughter trajectories cannot be constructed. For simplicity the possibility of obtaining the amplitude with one trajectory is considered; similarly the case of the amplitude with any finite number of trajectories can be discussed. (J.F.P.)

49630 SECONDARY STRUCTURE IN HIGH-ENERGY SCATTERING AMPLITUDES. Harrington, David R. (Rutgers-The State Univ., New Brunswick, N. J.). Amer. J. Phys.; 38: 1285-9(Nov 1970).

The dependence of the high-energy large-angle scattering amplitude on the detailed shape of the partial wave distribution or impact parameter shape factor is considered. Transformations of the partial wave series and impact parameter representations are derived which make explicit the dependence on the "smoothness" of these shapes. The transformations are also used to construct examples of partial wave distributions and shape factors leading to analytic expressions for the scattering amplitude showing clearly the dependence on the "surface thickness" of the distributions. (auth)

49631 NEW APPROACH TO THE REGGEON CALCULUS. I. Polkinghorne, J. C. (Cambridge Univ., Eng.). Nucl. Phys.; B16: 321-34(1970).

A new approach to the Reggeon calculus is formulated with the aid of Veneziano type functions to represent the Reggeon amplitudes. The singularities of signatured partial wave amplitudes are obtained from an analysis of integrals written in terms of Sudakov variables. No ad hoc assumptions about the significant region of integration are needed. As an example the singularity structure is derived corresponding to iterated Regge cuts. (auth)

49632 SOME SPECULATIONS ON THE POMERANCHUK TRAJECTORY. Fleming, H.; Predazzi, E. (Univ., Sao Paulo, Brazil). Lett. Nuovo Cim.; 4: 556-9(19 Sep 1970).

A possible explanation for the apparently abnormal behavior of the Pomeranchuk trajectory is considered. In the scheme discussed it appears that once the slope in the diffractive region is fixed from experimental data, the closer the trajectory to a linear form, the smaller the slope in the resonance region, so that the first recurrence may be as far away in the energy scale as to have, as yet, escaped detection. The starting point is the assumption of a once-subtracted dispersion relation together with the resonance width equation which is assumed from potential scattering. (J.F.P.)

Particle Accelerators

Refer also to abstracts 48307, 48308, 49142, 49229, 49299, 49777, and 49862.

49633 (CEAL-1052) SIMPLIFIED RADIAL SURVEY OF THE CEA MAGNET RING. Robinson, K. W.; Shurcliff, W. A. (Cambridge Electron Accelerator, Mass.). 10 Aug 1970. Contract AT(30-1)-2076. 31p. Dep. CFSTI.

The new radial-survey method entails use of two of the 48 magnets at a time, rather than four as in the earlier surveys. The line-of-sight is along the upper radially inner portions of the magnets and thus avoids interferences (by external beam-runs and the bypass) that since 1966 have made the earlier method useless. The longest line-of-sight is 26 ft, compared to 47 ft in the earlier surveys. The telescope-and-holder system is mounted on the given magnet in pre-leveled and pre-aimed manner, and the same applies to the optical-target-and-holder system. The systems are held in place by gravity; no clamps are used. No fixture plates are required and no leveling or aiming operations. The surveyor's rms error in making telescope readings of relative radial position is 0.001 inch. (auth)

49634 (INR-1181) THE ENERGY STABILIZATION SYSTEM FOR THE VAN DE GRAAFF ACCELERATOR "LECH." Ben'kovski, A.; Gurski, E.; Zemlo, L.; Katspshak, Z.; Leshchinski, M.; Yaskula, M. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 15p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The fast and slow stabilization systems of energy installed in the Van de Graaff accelerator "Lech" are described. The energy stability is better than $\pm 7 \cdot 10^{-4}$ in the beam energy range from 400 up to 2400 keV. (auth)

49635 (LA-4478) BIBLIOGRAPHY ON MAGNETIC FIELD MEASUREMENTS OF ACCELERATOR AND BEAM-HANDLING MAGNETS. Watt, Lore (comp.) (Los Alamos Scientific Lab., N. Mex.). Jul 1970. Contract W-7405-eng-36. 19p. Dep. CFSTI.

The bibliography includes abstracts from volumes 13 through 23 of NSA on (1) computer calculations of the field and/or of the particle trajectories in the field, and (2) actual physical measurements of the magnetic field including measurement techniques and measurements that have been made. Also, a collection of abstracts of papers presented at the Third International Conference on Magnet Technology held in Hamburg, Germany, on May 19-22, 1970, is included. (W.H.K.)

49636 (SLAC-126) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, 1 April-30 June 1970. (Stanford Linear Accelerator Center, Calif.). Sep 1970. Contracts AT(04-3)-400; AT(04-3)-515. 78p. Dep. CFSTI.

A status report on the Stanford Linear Accelerator Project covering the period April 1, 1970 to June 30, 1970 is presented. Topics included are accelerator and research area operations, accelerator and research area equipment development, and physics research equipment development. (auth)

49637 INTERFERENCE EXPERIMENT AND THE PHOTON STATISTICS FOR THE SYNCHROTRON RADIATION FROM ELECTRONS IN THE STORAGE DEVICE. Grishaev, I. A.; Naugol'nyi, N. N.; Reprintsev, L. V.; Tarasenko, A. S.; Shenderovich, A. M. Zh. Eksp. Teor. Fiz.; 59: 29-35(Jul 1970). (In Russian).

An interference experiment is performed on photons of the synchrotron radiation due to electrons in the storage device. It is shown that the synchrotron radiation produces an interference pattern in a Jamin interferometer which persists with decrease of light intensity down to that produced by several electrons in the orbit. The synchrotron radiation of such intensity consists of statistically independent photons. This is confirmed in particular by the analysis carried out in the present work of the quantum state of the electron radiation field in the storage device. Another confirmation is afforded by preliminary measurements of the pulse distribution function in an image converter. (auth)

49638 STABILIZATION OF DRIFT CYCLOTRON INSTABILITIES BY A HIGH-FREQUENCY ELECTRIC FIELD. Kitao,

Kazuo (Niigata Univ., Japan); Okamoto, Masao. Kakuyugo Kenkyu; 24: 127-40(Dec 1969). (In Japanese).

The stabilization of drift cyclotron waves by an outside electric field was investigated, and it was shown that the wave can be stabilized by the high frequency field. The condition for stabilization was determined by the intensity and the frequency of the electric field. (TSS) (Japan)

49639 NONLINEAR THEORY OF COLLECTIVE ACCELERATION OF IONS BY A RELATIVISTIC ELECTRON BEAM. Krasovitskii, V. B. Zh. Eksp. Teor. Fiz.; 59: 176-81(Jul 1970). (In Russian).

The problem of accelerating an ion beam by means of an electron beam is considered. The nonlinear analysis presented in the paper yields the characteristic parameters of the process, viz. the energy acquired by the ions, acceleration time and maximal density of the accelerated ion beam. (auth)

49640 FRINGING FIELD INTEGRALS FOR THIRD ORDER ION OPTICS. Rauscher, M. (Justus-Liebig Univ., Giessen, Ger.). Nucl. Instrum. Methods; 85: 333-4(1970).

The values of fringing field integrals for a third order approximation are calculated. The results are presented graphically. (auth)

49641 DETERMINATION OF CERTAIN PARAMETERS OF ARC ION SOURCE. Tauth, T.; Bajard, M.; Fiks, M.; Hadinger, G. (Univ., Lyon). Nucl. Instrum. Methods; 85: 237-43(1970). (In French).

To consider an optimal condition in the arc ion sources, we determined some relations between the most important parameters of the discharge. We expressed the cathodic sheath thickness, the total current, and the cathodic tension fall in terms of the average and maximum charges and the concentration of ions. The experimental points from various works are placed in a satisfying way on the calculated curves. (auth)

49642 OSCILLATORY PHENOMENA IN THE CATHODE ZONE OF AN ARC SOURCE. Tauth, T.; Bajard, M.; Chabert, A.; Hadinger, G. (Univ., Lyon). Nucl. Instrum. Methods; 85: 245-52(1970). (In French).

We analyzed the oscillations of insulated ions, in the field of the minimum cathodic potential of an arc ion source, in the consideration of the deformation of the well made by their presence. We came to the conclusion that these processes by their incoherence could not explain the observed oscillations. In considering the condition of the equality of the carriers of charges in the well, we determined its levelling time and the frequency of variation of its deepness. This variation, in our opinion, leads to the modulation of the intensity of electronic current and causes the cathodic oscillations. We drew the spectrum of the insulated ions and well frequencies, in terms of different parameters of the discharge. (auth)

49643 STUDY OF THE PHASE ACCEPTANCE OF A QUADRUPOLAR TRIPLET IN ITS DIVERGENT-CONVERGENT-DIVERGENT PLANE. Regenstreif, Edouard (Rennes Univ., France). Compt. Rend., Ser. B; 271: 194-7(20 Jul 1970). (In French).

Explicit formulae for calculating the phase acceptance of an arbitrary quadrupolar triplet in the divergent–convergent–divergent plane are developed. (France)

49644 NEW APPROACH TO PROTON LINAC BEAM DYNAMICS CALCULATIONS. Schnizer, Bernhard (CERN, Geneva, Technische Hochschule, Graz). Acta Phys. Austr.; 30: 223-41(1969).

A new method for the calculation of proton linac beam dynamics which differs in some points from that by Panofsky (1951) and by Lapostolle (Frascati, 1965) is proposed and the corresponding set of difference equations for particle coordinates is derived. The main difference is that gap centers of the Alvarez structure are abandoned as limits for the successive steps of the beam dynamics calculation. In each step, particle motion is followed from one drift tube center to the next one. The advantage of this new method is that beam dynamics equations for the first half of the gap, which involve the complicated S transit time coefficients, are no longer needed. The difference equations across the whole gap depend only upon the transit time factor in whose argument appears the particle velocity at the cell entrance, and upon the other input coordinates. This may imply that formulae presently used to calculate the transit time factor from fields found by mesh calculations are no more accurate enough. A modified formula is proposed. The equations of motion of a single proton in a linac gap are solved for input conditions (in place of mid-plane conditions) by first-order perturbation theory regarding the action of the accelerating radio frequency field as a perturbation upon free particle motion. Non-relativistic and relativistic difference equations for the change in longitudinal kinetic energy, phase, radial slope and radial position across a linac gap and along the first half of it are given at the end. (auth)

49645 MODELING OF PARTICLE MOTION IN A BETATRON CHAMBER WITH EXCITATION OF PARAMETRIC RESONANCE OF RADIAL FREE VIBRATIONS. Anokhin, V. P.; Kononov, B. A.; Ryzhkov, B. A. (Inst. of Nuclear Physics, Moscow, Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 39-43(1969). (In Russian).

The dynamics of amplitudes and phases of radial free oscillations of electrons with parametric resonance is modeled. The obtained solutions are discussed and are compared with solutions found by other methods. (tr-auth)

49646 COMPUTER-CONTROLLED MULTIPLE-DETECTOR ARRAY FOR HEAVY-ION EXPERIMENTS. Siemssen, R. H.; Fortune, H. T.; Tippie, J. W.; Yntema, J. L. (Argonne National Lab., Ill.). pp 174-7 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

An on-line computer at the Argonne tandem Van de Graff was used to determine and set the angles of the conjugate detectors, so that arrays of up to six pairs of coincident detectors could be handled simultaneously. The particles are detected in rectangular surface-barrier detectors. Two-dimensional coincidence spectra of 128 × 64 channels from the pairs of conjugate detectors are multiplexed into the 92K direct-access external memory of the on-line computer, and subsequently are read out on magnetic tape. (M.C.G.)

49647 INTRODUCTION TO THE STATE OF HEAVY-ION ACCELERATOR PROJECTS. Livingston, Robert S. (Oak Ridge National Lab., Tenn.). pp 498-517 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A brief historical review of heavy-ion accelerators is presented, and the earliest heavy-ion accelerators are listed. The present performance of heavy-ion accelerators is discussed, and heavy-ion machines operating during and after 1958 are listed. The design and performance of available heavy-ion sources are outlined. The various types of heavy-ion accelerators are reviewed, and tables are presented which summarize heavy-ion projects and proposals. (35 references) (W.H.K.)

49648 UNILAC, A VARIABLE ENERGY HEAVY-ION LINEAR ACCELERATOR. Blasche, K.; Boehne, D.; Schmelzer, Ch.; Stadler, B. (Univ., Heidelberg). pp 518-39 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The general idea and particular design aims of the UNILAC, including machine parameters and related data, are reviewed. Further details are given on expected properties of the output beam: maximum output energy versus mass number, range of energy variation, and output particle current versus ion species. Aspects of beam quality (energy spread and time resolution of output particle bunches with and without debuncher, and radial beam emittance) are discussed. The feature of an incorporated isotope separator and the implications of single- and multicharge acceleration are mentioned briefly. The present state of the project is summarized. Beam intensity measurements of multi-charged ions are reported for a Duoplasmatron and a cold cathode Penning source. Results on high voltage experiments with electrostatic quadrupole lenses mounted into drift tubes, and high power tests with a single-gap cavity are reported. Spark rate and x-ray level are given as a function of gap gradient. (auth)

49649 HELAC: THE HELIX LINEAR ACCELERATOR FOR HEAVY IONS. Klein, H.; Junior, P.; Klabunde, J.; Siart, O.; Deitinghoff, H.; Finke, P.; Schempp, A. (Univ., Franfurt am Main). pp 540-56 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The design and principle of operation of the HELAC linear accelerator for acceleration of heavy ions in a helical waveguide are described. (W.H.K.)

49650 STATE OF THE HEAVY-ION ACCELERATOR PROJECT: ALICE. Lefort, M.; Cabrespine, A. (Institut de Physique Nucleaire, Orsay, France). pp 557-60 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The project which is under construction at Orsay (ALICE) which consists essentially in the connection of a linear accelerator and a cyclotron is described. Heavy ions are accelerated in the LINAC up to 1 MeV per nucleon. The ions are transported into the central area of the cyclotron where they are stripped of a number of electrons. The stripping foil takes the place of a classical ion source and the average charge state is much higher than in any multicharged ion source. Since the energy at the extraction radius of the cyclotron is proportional to the square of the number of charges, a high energy can be reached. The characteristics of the isochronous cyclotron are the same as previously. It delivers a variable energy beam with a very good duty cycle. (auth)

49651 HEAVY ION LINEAR ACCELERATOR PROJECT OF LYON. Chabert, A.; Tran Duc Tien; Volsin, G. (Univ. , Lyon). pp 561-7 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The injector and accelerating structure for the heavy-ion linear accelerator project at Lyon University are discussed. (W.H.K.)

49652 STATE OF THE STUDIES CONCERNING AN ACCELERATOR FOR VERY HEAVY IONS (CHARGE-CHANGE-ACCELERATOR). Hortig, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 568-71 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The status of the development of the charge-change accelerator for heavy ions is reported. This accelerator relies on successive stripping in alternative gas and solid phase strippers. In a dc potential under these conditions many cycles of dual stripping result in the buildup to very high energies of ions injected into the device. Methods for injection and extraction are discussed. (W.H.K.)

49653 HILAB PROPOSAL. Grodzins, L. (Massachusetts Inst. of Tech., Cambridge). pp 572-82 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The proposed HILAB heavy-ion accelerator is described. The accelerator consists of two tandem Van de Graaff accelerators. A TU tandem acts as injector for an MP tandem accelerator. (W.H.K.)

49654 APACHE, AN ACCELERATOR FOR PHYSICS AND CHEMISTRY OF HEAVY ELEMENTS. Zucker, A. (Oak Ridge National Lab., Tenn.). pp 583-600 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The Apache heavy-ion accelerator proposal for accelerating ions of all elements to at least 7.5 MeV/A is described. The accelerator consists of a TU tandem injector and a separated-sector cyclotron. Also, a smaller cyclotron may be used for injection into the separated-sector cyclotron. The ion beams and energies expected to be obtained in the various modes of operation are listed. Also, the ion stripping process is described. (W.H.K.)

49655 MIDWEST TANDEM CYCLOTRON PROPOSAL. Morrison, G. C. (Argonne National Lab., Ill.). pp 601-14 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The Midwest Tandem Cyclotron (MTC) proposal for a heavy-ion accelerator consisting of a TU tandem injector and a six-sector cyclotron is described. Bunching, charge state selection, and vacuum conditions for the TU tandem are described; characteristics of the open-sector cyclotron are discussed; and the building plan is proposed. (W.H.K.)

49656 TANDETRON. Purser, K. H. (Univ. of Rochester, N. Y.). pp 615-22 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The proposed TANDETRON heavy-ion accelerator consisting of an MP tandem Van De Graaff injector and a split-sector cyclotron is described. Negative ion injection, the MP tandem, the split-sector cyclotron, and beam characteristics are discussed. (W.H.K.)

49657 MODEL TU TANDEM VAN DE GRAAFF. Shaw, J.; Chmara, F.; Galejs, A.; Goldie, C. (High Voltage Engineering Corp., Burlington, Mass.). pp 623-6 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Design of the TU 20 Megavolt tandem and a parallel test and development program on the factory MP facility were initiated in early 1967. The general design is based on the MP with the overall length of 80 feet, and the column insulating length of 24 feet, both identical to those of the MP. The major new features are a larger 25-foot ID tank, improved high-gradient column, tube and voltage-dividing resistors, and an intermediate shell subdividing the terminal to tank gap. This intermediate shell is 24 feet long, 10.8 feet diameter, and will operate at 75% of the total voltage. The prototype tank is rated for a maximum pressure of 135 psig with the expectation that the operating gas would be pure SF6 at approximately 100 psig. Meanwhile, the test program has shown the desirability of increasing the pressure rating of production models to provide more flexibility for operation in gas mixtures. Assembly of the accelerator is well underway and testing of the voltage generator, exclusive of the intershell, will start in summer 1969. The schedule calls for installation of tubes and testing as an accelerator to start the first of 1970, with addition of the intershell in late spring 1970. (auth)

49658 BEAM INJECTION AND ACCELERATION IN THE MILAC AND A DISCUSSION OF A DOUBLE TUBE VERSION. Miessner, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 627-9 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A double tube version of the charge-change heavy-ion accelerator proposed by Hortig is described. The double tube version has separated accelerating and decelerating sections. Advantages of the double tube version are discussed. (W.H.K.)

49659 RESEARCH AT THE PS. 2. BUBBLE CHAMBER EXPERIMENTS. Meyer, J. CERN Cour.; 11: 352-4(Nov 1969).

Some major results obtained with hydrogen and heavy liquid bubble chambers in studying weak interactions, particle and resonance production, and production mechanisms are listed. (C.E.S.)

49660 RESEARCH AT THE PS. 1. ELECTRONICS EXPERIMENTS. Cocconi, G. CERN Cour.; 11: 349-51(Nov 1969).

Some highlights of the particle physics research carried out at the proton synchrotron during the past ten years involving the use of counters and spark chambers are presented. (L.B.S.)

49661 ACCELERATING SYSTEM OF AN IRON-FREE WAVEGUIDE SYNCHROTRON. Gos'kov, P. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 111-14(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 155-9(Jan 1970).

We analyze a complex two-period, crossed-ladder waveguide structure, whose use as an accelerating system in an iron-free waveguide synchrotron eliminates the shielding of the high-frequency magnetic guide field and yields a significant simplification in the construction of an accelerating system. Results are given of a theoretical and experimental investigation of the dispersion properties of this structure. (auth)

49662 RADIAL MOTION OF ELECTRONS AND BEAM FOCUSING IN A 300-MeV LINEAR ACCELERATOR ALLOWING FOR THE EFFECT OF ELECTRICAL FIELD ASYMMETRY IN MATCHING ELEMENTS OF ACCELERATING SECTIONS. Grishaev, I. A.; Dem'yanenko, G.K.; Rubtsov, K. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 106-10(Jul 1970).

Translated from Zh. Tekh. Fiz.; 40: 149-54(Jan 1970).

The radial motion of electrons in a linear accelerator is discussed taking into account the effect of disturbing forces due to the asymmetry of the electric field in the matching elements of the accelerating sections. It is shown experimentally that the

magnitude of this force depends upon the amplitude and phase of the accelerating wave. The particle trajectory is calculated taking into account the effect of this force and optimum parameters of focusing elements are computed which make it possible to obtain a beam of 300-MeV electrons with a diameter of 0.4 to 0.5 cm and a divergence smaller than 10^{-4} rad. (auth)

49663 1959–1969 TEN YEARS IN THE LIFE OF A MACHINE. CERN Cour.; 11: 337-48(Nov 1969).

A review is given of the past ten years experience in the operation and development of the CERN proton synchrotron. A brief sketch is also given of future developments in the proton synchrotron performance and in experimental facilities as a part of the PS improvement program and intersecting storage rings project. (L.B.S.)

49664 CHANNEL OF NEGATIVE PARTICLE BEAMS WITH MOMENTUM UP TO 60 GeV/c. Aleksandrov, I. A.; Grachev, M. I.; Gubrienko, K. I.; (and others). At. Energ. (USSR); 29: 29-35(Jul 1970). (In Russian).

The transport channel of negative particle beams with momentum up to 60 GeV/c, generated on an inner target at the energy of accelerated protons of 70 GeV is described. The channel is calculated in such a way that at the energy of accelerated protons 70 GeV it can be tuned for any momentum of the secondaries within the range from 40–60 GeV/c. When the energy of accelerated protons is decreased the channel can be tuned for a lower momentum. The lower limit with respect to the secondaries momentum corresponds to the accelerated proton energy of 20 GeV and it equals 11.4 GeV/c. The optical system of the beam channel and its designed characteristics are presented. The limit solid angle on the secondary beam capture is equal to 32 μsterd. The best resolution with respect to the momentum is 0.3% without any considerable losses of intensity. The investigation of the beam channel properties is mainly carried out at the secondary beam momentum of 50 GeV/c. The procedure of the beam tuning and the calculated data for the beam with the given momentum value are described. The difference between the designed regimes of the beam channel units and the results of tuning does not exceed summed errors of the accelerator scattering fields, magnetization curves and calibrating data with respect to the shunts of the magnets. The beam parameters through the whole beam channel agree well with the calculated data. (auth)

49665 DETERMINATION OF THE OPTIMUM FOCUSING CONDITIONS FOR CHARGED PARTICLES. Glasko, V. B.; Sveshnikov, A. G.; Semashko, N. N. (Moscow State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 196-9(Aug 1970). Translated from Zh. Tekh. Fiz.; 40: 270-4(Feb 1970).

An algorithm for determining the parameters of a magnetic system providing conditions of charged particle focusing that are optimum in a certain sense is developed. The problem is solved in the single-particle approximation. The algorithm is based on a certain variational functional whose extremal values are determined by numerical methods. Examples of calculations of several actual focusing systems based on the general method are given. (auth)

49666 OPTIMIZATION OF THE PHASE-FOCUSING CHARACTERISTICS OF AN ANALYZER FOR THE ANALYSIS OF A THREE-COMPONENT BEAM. Glazkov, A. A.; Babkin, B. N. (Inst. of Physical Engineering, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 206-10(Aug 1970). Translated from Zh. Tekh. Fiz.; 40: 283-9(Feb 1970).

Problems connected with the phase focusing characteristics of a two-section waveguide analyzer are investigated in detail. It is generally assumed that a three-section analyzer is needed to analyze over a wide momentum range a given particle against a background consisting of two other particles. However, the present work shows that good results can be achieved by optimizing the phase focusing of an analyzer consisting of two sections. Numerical estimates have been carried out for the analyzing channel of a "cybernetic" accelerator operating in the 1000 GeV range. (auth)

49667 ACCELERATION OF ELECTRONS IN A MICROTRON WITH AN INHOMOGENEOUS MAGNETIC FIELD. Luk'yanenko, E. A.; Melekhin, V. N. (Inst. for Physical Problems, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 311-13(Aug 1970). Translated from Zh. Tekh. Fiz.; 40: 414-16(Feb 1970).

The conclusion that it is possible to accelerate electrons in a microtron having an inhomogeneous magnetic field which is symmetric with respect to the common diameter of the orbits has been confirmed experimentally. The experiments were performed on a 30-orbit microtron. The introduction of an inhomogeneity into the field, amounting to 2% at the edge of the magnet, has an insignificant change in the current distribution over the orbits but increases markedly the stability of the radial motion and decreases the radial angular divergence of the accelerated beam. (auth)

49668 ACCELERATING STRUCTURE WITH IRISES AND DRIFT TUBES FOR A PROTON LINEAR ACCELERATOR. Andreev, V. G.; Pashkovskii, V. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 405-9(Sep 1970). Translated from Zh. Tekh. Fiz.; 40: 523-8(Mar 1970).

The paper gives the basic parameters of an accelerating structure in the form of a cylindrical cavity resonator containing conducting irises supplemented by drift tubes. Geometric dimensions for the accelerating structure were determined which are optimal in the sense of economic use of high-frequency power for proton acceleration. (auth)

49669 FOCUSING OF ION BEAMS IN TWO-DIMENSIONAL MAGNETIC FIELDS. Malov, A. F.; Zaboev, A. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 418-25(Sep 1970). Translated from Zh. Tekh. Fiz.; 40: 538-50(Mar 1970).

The present article develops an analytic theory of the horizontal focusing of a beam in an inhomogeneous two-dimensional magnetic field by retaining terms up to and including the third order in the angles of the horizontal divergence of the beam. The focusing fields obtained are independent of x and vary nonmonotonically with y in the plane z = 0. Calculations soon to be published show that in some fields of this type images are obtained in the focal plane which are characterized by small horizontal and vertical aberrations. Design equations are obtained which can be used to design high-yield mass separators of large dispersion and alpha and beta spectrometers with high resolution and transmission. (auth)

49670 ENERGY AND ENERGETIC DISPERSION OF IONS TRANSVERSAL TO MAGNETIC FIELD IN SOURCE WITH OSCILLATING ELECTRONS. Grigorov, G.; Borissova, F. (Inst. of Electronics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 23: 655-8(1970).

The energy distribution of ions from a plasma source with oscillating electrons under conditions of instability is studied. The source contains a hot tungsten cathode, a ring-shaped anode, and a disc-shaped electrode. The energy distribution is studied as a function of the magnetic field, anode voltage, and discharge current. (W.H.K.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 48309, 49227, 49242, 49268, and 49862.

49671 (AAEC/TM-539) APPROXIMATION FOR SELF-SHIELDING. Bunder, M. W.; Keane, A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr 1970. 18p. Dep. CFSTI (U. S. Sales Only).

Self-shielding data for ^{238}U were fitted to a three-parameter formula for inclusion in the GYMEA library. With dilution and temperature variations included it is not possible to reproduce the results exactly but the work has aimed at reproducing the correct effective resonance integral while making the contribution to each group as correct as possible. (auth) (Australia)

49672 (AD-698832) LUTE AND LATEX: SPECIAL-PURPOSE CODES TO TRANSLATE FROM MODIFIED-UK TO ENDF/B FORMAT. Dudziak, Donald J.; Cook, Jason M. (Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences). Aug 1969. Contract DASA01-69-C-0029. 79p. (NE-3383-102-69-U). CFSTI.

Two special-purpose FORTRAN IV codes were written to translate neutron interaction and photon production data from an extended version of the UK Data File format to Evaluated Nuclear Data File/B Data File format. The codes operate only on the subset of the general UK neutron data format which was used for the Defense Atomic Support Agency (DASA) sponsored evaluations of sodium, magnesium, silicon, chlorine, potassium and calcium. Descriptions of the codes' functions and operation are given, along with input instructions, output descriptions, and INDEX'ed listings of all main programs and subroutines. (auth) (USGRDR)

49673 (AECL-3605) ACCURACY OF dg/dT FOR FISSILE ISOTOPES, WITH REFERENCE TO ENDF/B (AND OTHER) DATA FILES. Westcott, C. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1970. 29p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

This work arose as an extension of a study of the accuracy of the g-factors (for 20°C) for the nuclides ^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu, and from the regression analysis of a recent review of the 2200 m/sec constants (σ_a, σ_f, α, ν, η, etc) for the same isotopes. The ENDF/B files for these elements are now under revision. It appears desirable to estimate also the possible inaccuracies of the g's at temperatures above 20°C, i.e., of the effective cross sections $\hat{\sigma}$ for Maxwellian (and thence for thermal-reactor) spectra for the same isotopes. It is found, and was confirmed by typical lattice calculations, that this uncertainty in dg/dT gives rise to a significant contribution when a reactor temperature coefficient is evaluated, although it does not represent a major increase over previously-estimated errors. (auth)

49674 (AEEW-R-685) REVIEW OF THERMAL NEUTRON DIFFUSION DATA FOR HEAVY WATER AND ITS CONSEQUENCES FOR NEUTRON SCATTERING LAW MODELS. Butland, A. T. D.; Chudley, C. T. (Atomic Energy Establishment, Winfrith (England)). Nov 1969. 36p. Dep. CFSTI (U. S. Sales Only). UK 5s.

In this paper the form and origins of the Effective Width and Honeck Models for thermal neutron scattering in heavy water are briefly described, and the validity of the derived cross-sections is tested in a practical manner by comparisons with available integral data on the neutron diffusion coefficient of heavy water, and with differential measurements of the total neutron cross-section. (auth) (UK)

49675 (AHSB(S)R-184) USE OF THE U.K. NUCLEAR DATA LIBRARY IN THE MONTE CARLO PROGRAM MONK. Hemmings, P. J. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1970. 55p. Dep. CFSTI (U. S. Sales Only).

The need for nuclear data by a neutron or gamma ray transport code based on the Monte Carlo method is discussed. It is shown how the U.K. Nuclear Data Library may be used and how data may be stored in a convenient manner for ready access. Subroutines which use this nuclear data to determine collision points and the consequences of collisions are described. A subsidiary code POND4 which pre-processes the original data library is also described. (auth) (UK)

49676 (EURFNR-782) NEUTRON NUCLEAR DATA COMPILATION AND EVALUATION: PAST, PRESENT, AND FUTURE. Schmidt, J. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Dec 1969. 23p. (KFK-1075; EANDC(E)-124-U). Dep. CFSTI (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

In response to the increasing demands of the nuclear community a world-wide organizational effort has developed particularly in the last ten years in the compilation and evaluation of all experimental information in the field of neutron nuclear data. Supra-regional committees like the European American Nuclear Data Committee (EANDC) and its local subcommittees and more also the International Nuclear Data Committee (INDC) have made substantial contributions to the international organization and coordination of this effort. At present the task of getting the bibliographic and experimental information systematically compiled all over the world, stored and distributed to a variety of customers is subdivided primarily among four centers for neutron nuclear data at Obninsk in USSR (NDIC), at the IAEA in Vienna (NDU), through the ENEA at Saclay in France (CCDN) and at Brookhaven in the USA (NNCSC) with separate service areas. More and more these centers also provide for the storage and exchange of evaluated neutron nuclear data files originating from various laboratories all over the world. (auth)

49677 (GA-8774) REFERENCE MANUAL FOR ENDF THERMAL NEUTRON SCATTERING DATA. Koppel, J. U.; Houston, D. H. (Gulf General Atomic, Inc., San Diego, Calif.). 16 Dec 1968. Contract AT(04-3)-167. 172p. Dep. CFSTI.

A general reference guide to the information concerning the thermal neutron scattering law data submitted by Gulf General Atomic to the Evaluated Nuclear Data File is presented. The ENDF system is described, and a concise description of the computer codes used to generate the scattering data is given. The data corresponding to the various moderators studied are tabulated. (J.W.R.)

49678 (GEAP-13592) ENDRUN-1: A COMPUTER CODE TO GENERATE A GENERALIZED MULTIGROUP DATA FILE FROM ENDF/B. Hutchins, B. A.; Price, L. N. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Apr 1970. Contract AT(04-3)-189. 144p. Dep. CFSTI.

The ENDRUN-1 program, which calculates multigroup constants from ENDF/B data, is described. The problem and the method of solution are discussed in detail. A sample problem is solved as an illustration. The program is written in FORTRAN IV except for input and output routines. The program was written for the GE 635 computer. (J.W.R.)

49679 (ITF-70-30) COHERENT EFFECTS IN SLOW NEUTRONS SCATTERING ON LOCAL VIBRATIONS. Kochmarskii, V. Z. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 22p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The differential cross section for slow neutron scattering on local vibrations in various symmetries was obtained for a first order impurity atom concentration and considering the dynamical matrix local change. An impurity interacting with its nearest neighbors in a cubic crystal was considered as an example. It is shown that the dependence of the differential cross section on the momentum transfer is determined by the local vibration symmetry. This fact may be used to help identify local vibrations. (auth)

49680 (KFKI-70-6) NEUTRON AVERAGE ENERGIES: CALCULATIONS AND THEORY OF MEASUREMENTS. Makra, S. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1970]. 24p. Dep. CFSTI (U. S. Sales Only).

The average energies of reactor neutrons penetrating through various shielding walls and theories of attenuation techniques (Block and Shon and paired Bonner-sphere techniques) are presented. A comparison was made of calculated and measured values. (M.C.G.)

49681 (LA-4429) TESTS OF NEUTRON CROSS SECTIONS. Mills, Carroll B. (Los Alamos Scientific Lab., N. Mex.). Apr 1970. Contract W-7405-eng-36. 30p. Dep. CFSTI.

Analysis involving the interaction of neutrons with matter over the energy range of 0 to 14 MeV require a knowledge of differential neutron cross sections as well as the results of measurements showing the kinds and magnitudes of these interactions. The study of integral experimental results on neutron multiplication in a variety of assemblies and of the effects of inserting a variety of

materials into these assemblies permits examination of cross sections for improved accuracy. These improvements are qualitative and indicate areas of interest for supplementary differential measurements. Materials of interest to power breeder reactor physics and for application to high-temperature, gas-cooled reactors were tested for accuracy by perturbation theory methods. The values were generally found to be approximately correct. (auth)

49682 (ORNL-TM-3065) STATUS OF NEUTRON TRANSPORT IN THE ATMOSPHERE. Straker, E. A. (Oak Ridge National Lab., Tenn.). 29 Jul 1970. 29p. Dep. CFSTI.

Attempts have been made since the mid 1940's at determining the radiation fields from nuclear weapons. Earlier attempts were experimental in nature with the efforts in the first few years being mostly calculational. A review of the progress that has been made in the past few years, the information that is currently available, and approaches to solving the problem of determining the detailed radiation field description is given. (51 references) (auth)

49683 (RISO-196) STUDIES IN NEUTRON PHYSICS. I. THERMAL NEUTRON BEAM STANDARDIZATION BY MEANS OF THE ^{3}He(n,p)T REACTION. II. THE ORDER-DISORDER TRANSITION IN BETA-BRASS STUDIED BY NEUTRON DIFFRACTION. Als-Nielsen, J. (Danish Atomic Energy Commission, Risoe, Research Establishment). Apr 1969. 82p. Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Copenhagen, Denmark.

A series of experimental investigations in nuclear physics and solid state physics utilizing thermal neutrons from the DR 3 reactor at Risö is reviewed. The nuclear physics experiments concern a method employing the ^{3}He(n,p)T reaction for standardization of thermal neutron beams. These experiments made up some of the investigations necessary for the recently completed measurement of the free neutron half-life. The solid state physics experiment deals with the study of order-disorder transition in beta-brass by neutron diffraction techniques. These experiments were carried out for comparison with modern theories of critical phenomena accompanying second-order phase transitions. (77 references). (auth) (Denmark)

49684 (RT/FI-(69)45) NUMERICAL APPLICATIONS OF A NEW APPROACH TO THE SOLUTION OF THE NEUTRON TRANSPORT EQUATION. Cupini, E.; de Matteis, A.; Premuda, F.; Trombetti, T. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 14 Oct 1969. 56p. Dep. CFSTI (U. S. Sales Only).

The results of a feasibility study concerning the numerical applications of a new method for the solution of the stationary neutron transport equation with isotropic scattering are described. The two following problems of reactor physics are treated: (1) finite plane slab with monoenergetic neutrons (calculation of the critical parameter and of the neutron flux distributions in the critical and subcritical cases); (2) finite plane slab with two neutron energy groups, in the critical case. Possible extensions of the method are also discussed. (auth)

49685 (RT/FIMA-(69)5) COLLIMATION CORRECTIONS IN SMALL ANGLE SCATTERING OF NEUTRONS. Antonini, M. (Comitato Nazionale per l'Energia Nucleare, Ispra (Italy)); Daneri, A.; Toselli, G. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). [1969]. 31p. Dep. CFSTI (U. S. Sales Only).

A numerical technique is developed for correcting experimental data on small angle diffuse scattering of neutrons for the effect of instrumental resolution in the static approximation. The unfolding method does not require any particular priori theorical prediction on the form of the differential cross section while the resolution is assumed to be the product of two independent Gaussian functions representing the effect of the finite angular divergencies of the incident and scattered beams in the scattering plane (horizontal collimation) and in the normal plane (vertical collimation). The validity of the procedure is tested under various typical experimental conditions and the results are discussed also in connection with random errors affecting the input data. (auth)

49686 RESONANCE OVERLAP EFFECT ON EFFECTIVE CROSS SECTION IN UNRESOLVED RESONANCE REGION. Nakamura, Kunihiko; Nishihara, Hiroshi (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 239-47(May 1970).

The effect of resonance overlap on the effective cross section was studied in the unresolved resonance region. The sequential overlap between resonances belonging to the same sequence of an isotope was studied by a method that approaches Method A at higher energies and Method B at lower energies. The accidental overlap effect between different sequences was studied in reference to factors for overlap correction and flux correction. Numerical studies indicate that in large fast reactors, when an average is taken over the distribution of level spacing, a greater influence is provided on the effective cross section by the sequential as compared with the accidental overlap. (auth)

49687 INCOHERENT MULTIPLE SCATTERING OF NEUTRONS. Men'shikov, A. Z.; Bogdanov, S. G. (Inst. of Metal Physics, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 15: 211-13(Sep-Oct 1970).

Translated from Kristallografiya; 15: 252-5(Mar-Apr 1970).

An experimental investigation was made of the angular dependence of the multiple incoherent scattering of neutrons on V slabs The experimental results are compared with Vineyard's theory. Numerical values for the multiple scattering were calculated by means of a computer. Recommendations are given for the allowance for multiple scattering. (auth)

49688 SPECTRA OF PERTURBED SEMIGROUPS WITH APPLICATIONS TO TRANSPORT THEORY. Vidav, Ivan (Univ., Ljubljana, Yugoslavia). J. Math. Anal. Appl.; 30: 264-79(May 1970).

The Boltzmann operator is written as the sum of a bounded operator and another operator which is the generator of a strongly continuous semigroup. The general solution of the transport equation is then expanded in terms of special solutions. The problems encountered in this expansion are met by studying the spectrum of the semigroup operator. Some applications in neutron transport theory are illustrated. (J.W.R.)

49689 INITIAL VALUE PROBLEM FOR NEUTRON TRANSPORT IN A SLAB WITH PERFECT REFLECTION BOUNDARY CONDITIONS. Belleni-Morante, A. (Univ. of Illinois, Urbana). J. Math. Anal. Appl.; 30: 353-74(May 1970).

The initial-value problem for neutron transport in a homogeneous slab with perfect reflection boundary conditions is studied and the existence and the uniqueness of the solution are established. The structure of the spectrum of the transport operator is also investigated, and it is proven that at least one real eigenvalue always exists. (auth)

49690 ACCELERATION APPARATUS FOR THE PRODUCTION OF X-RAYS AND NEUTRONS. Uleski, Robert C. U. S. Patent 3,518,432. 30 Jun 1970. Filed 17 Oct 1967.

Acceleration apparatus having a beam tube with an aluminum target at one end of the tube and a beryllium target at the other end of the tube is described. The targets are respectively provided with a positive accelerating potential and a negative accelerating potential. A particle source, utilizing an ionization mechanism and a propelling magnetic field, is employed to feed electrons and positively charged particles into the beam tube at a place intermediate the targets. A third target, uranium, is disposed externally of the beam tube in the vicinity of the beryllium target. The electrons, as they are fed into the beam tube, are accelerated toward and bombard the aluminum target to produce x-rays. The positively charged particles, as they are fed into the beam tube, are accelerated toward and bombard the beryllium target. It is known, that when beryllium is bombarded by positively charged particles, the reaction releases neutrons. The released neutrons in turn bombard the uranium. The latter reaction produces plutonium 239. The electrons and the positively charged particles (propellant masses) are accelerated in substantially a vacuum environment. The high voltage source for energizing the aluminum target and the beryllium target features a first hollow substantially spherical ball, such as that used in a Van de Graaff generator. A second hollow substantially spherical ball is disposed adjacent, and electrically connected, to the Van de Graaff ball. Preferably the two balls are covered with an insulating plastic shield to decrease corona discharge. (auth)

49691 INTEGRAL FORM OF THE BOLTZMANN EQUATION OF NEUTRON TRANSPORT AS APPLIED TO FINITE CELLS. Zischka, K. A. (Univ. of Windsor, Ont.). SIAM (Soc. Ind. Appl. Math.) J. Appl. Math.; 18: 584-95(May 1970).

The kernel of the integral transport equation corresponding to a given boundary value problem for the Boltzmann equation is derived. The angular density of the incident neutrons on the boundary may be specified or not. For the former case an integral equation is derived, and the integral equation for the neutron density in a cylindrical cell with "isotropic spectrum boundary condition" in cylindrical coordinates is given. The latter case is treated by means of Green's functions. The problem of finding the Green's function for a heterogeneous cell can be reduced to that of finding one for the homogenized cell, although this case can usually be avoided in practice. The specular reflecting boundary condition loses its absolute relevance when one approximates a hexagonal

cell with a cylindrical cell, and it is reasonable to employ the "isotropic spectrum boundary condition" in this instance. (R.W.R.)

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Refer also to abstracts 49683, 49767, and 49952.

49692 (WANL-TME-2713) SOME NEW THERMAL-NEUTRON CAPTURE-GAMMA YIELDS FOR THE WANL POINT LIBRARY. Fody, S. A. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Jul 1970. 34p. Dep. CFSTI.

Thermal-neutron capture-gamma yield tables are presented for the following elements: H, Be, C, N, Na, Mg, Al, Si, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Zr, Nb, Mo, Ag, Cd, Gd, Hf, Ta, W, Au, and Pb. (L.T.W.)

49693 APPLICATION OF TWO-BODY INTERACTION TO THE CALCULATION OF ^{4}He ENERGY. Wada, Hiroshi (Tokyo Inst. of Tech.). Soryushiron Kenkyu; 40: No. 4, D12-15(Dec 1969). (In Japanese).

The binding energy of $^4H_\alpha$, the single particle energy for $^4H_\alpha$ core and the energy spectrum of ^6L_i were calculated with the two-body interaction based on the G matrix theory by Bruckner. The result of the numerical calculation performed with Hamada-Johnstone potential as the two-body interaction was compared with experimental results. The calculated ground state energy of $^4H_\alpha$ and the calculated root mean square radius of the charge distribution of $^4H_\alpha$ were in agreement with experimental results. The single particle energy of $^4H_\alpha$ core and the energy spectrum of ^6L_i were also calculated and shown graphically. (NSA of Japan)

49694 REQUIREMENTS FOR A ^{4}He TRIAL WAVE FUNCTION. Hutzelmeyer, H. (Univ., Cologne). Nucl. Phys.; A153: 172-82 (1970).

The form of a variational ansatz for the wave function of ^{4}He is discussed. It is shown that besides symmetry considerations one has to allow for correlations in the wave function of both short-range "Jastrov" and long-range "cluster" types. The influence of these correlations on the charge form factor is investigated; a simple calculation for a soft-core potential and some systematic dependencies of the form factor are presented. (auth)

49695 ^{3}H(d,n)^{4}He REACTION BELOW 1 MeV. Seiler, F.; Baumgartner, E. (Univ. of Basel). Nucl. Phys.; A153: 193-210(1970).

The possibility of an analysis of the ^{3}H(d,n)^{4}He reaction below 1 MeV is investigated. This is done in terms of a limited set of (l,s,J) matrix elements, independent of specific models for the interaction. Sufficient experimental data for such an analysis can be obtained by supplementing available information with measurements of the neutron polarization using polarized deuterons. Linear relations between redundant data are given, offering consistency checks between different experiments at the same energy. (auth)

49696 MEASUREMENT OF THE TENSOR POLARIZATION $\langle T_{20}\rangle$ IN DEUTERON-ALPHA ELASTIC SCATTERING. Koenig, V.; Gruebler, W.; Schmelzbach, P. A.; Marmier, P. (Eidgenoessische Technische Hochschule, Zurich). Nucl. Phys.; A148: 380-90(1970).

The tensor polarization parameter $\langle T_{20}\rangle$ of deuterons elastically scattered on ^{4}He has been measured with the polarized deuteron beam from the ETH tandem accelerator. Measurements were made at c.m. angles between 33.6° and 145.8° in the energy range 3 to 11.5 MeV. The results show that d-α scattering is useful as an analyser for deuteron tensor polarization for deuteron energies in excess of 4 MeV. (auth)

49697 MEASUREMENT OF THE TENSOR POLARIZATION $\langle T_{21}\rangle$ AND $\langle T_{22}\rangle$ IN DEUTERON-ALPHA ELASTIC SCATTERING. Gruebler, W.; Koenig, V.; Schmelzbach, P. A.; Marmier, P. M. (Eidgenoessische Technische Hochschule, Zurich). Nucl. Phys.; A148: 391-400(1970).

The tensor polarization parameters $\langle T_{21}\rangle$ and $T_{22}\rangle$ have been measured with a polarized deuteron beam at c.m. angles between 33.6° and 145.8° in the energy range 3 to 11.5 MeV. The results show that d-α scattering is useful as an analyser for the deuteron tensor polarization $\langle T_{22}\rangle$ for deuteron energy in excess of 4 MeV. The tensor component $\langle T_{21}\rangle$ is small at most energies, reaching a maximum value of $\langle T_{21}\rangle = +0.26$ at $E_d = 4.81$ MeV. (auth)

49698 DIRECT APPLICATION OF THE QUASI-PARTICLE METHOD TO A THREE-NUCLEON SYSTEM. Appel, Kurt (Technische Univ., Hanover). Z. Phys.; 235: 446-52(1970).

The energy dependence of the expectation values of powers of the Lippmann-Schwinger operator, $k_\alpha(W) = \langle\gamma|V(G_0(W)\cdot V)^k|\gamma\rangle$, is used to calculate the groundstate energy of the triton for a simple central two-nucleon interaction of Gaussian type. This method allows to calculate the exact energy eigenvalue E_0 of a three-nucleon-system in principle with any desired precision. The calculations are performed until k = 3. In this approximation the value $E_3^{(3)} = -13.25$ MeV is obtained which is simultaneously an upper bound of the true groundstate energy E_0 of the system. (auth)

49699 BETA DECAY OF TRITIUM. Lewis, V. E. (National Physical Lab., Teddington, Eng.). Nucl. Phys.; A151: 120-8(1970).

The β-spectrum of tritium was investigated down to energies of about 1½ keV using a lithium-drifted silicon detector with tritons implanted in the depletion layer. The end-point energy was determined as 18.540 ± 0.095 keV, assuming a zero anti-neutrino rest mass. The random and systematic uncertainties are ±0.065 keV and ±0.070 keV respectively, and all uncertainties are quoted for 95% confidence levels. Taking the triton half-life as 12.35 ± 0.05 y, an ft value of 1144 ± 9 sec is deduced. With a neutron ft value of 1109 ± 17 sec this result indicates a positive pion exchange enhancement of the triton GT matrix element. (auth)

49700 ELASTIC SCATTERING OF ^{3}He BY TRITIUM. Batten, R. J.; Clough, D. L.; England, J. B. A.; Harris, R. G.; Worledge, D. H. (Univ. of Birmingham, Eng.). Nucl. Phys.; A151: 56-64 (1970).

Differential cross sections for the elastic scattering of ^{3}He from tritium at 27.7 and 32.3 MeV have been measured in the c.m. angular range from 50° to 180°. Excitation functions for this elastic scattering at c.m. angles of 60°, 90°, 120° and 150° have also been measured in the energy range from 24.7 to 33.4 MeV. The angular distributions and the excitation functions are compared with the predictions of one-channel resonating group theory. (auth)

49701 ^{3}H(p,γ)^{4}He REACTION FROM 3 TO 18 MeV. Meyerhof, Walter E.; Suffert, Martin; Feldman, William (Stanford Univ., Calif.). Nucl. Phys.; A148: 211-24(1970).

The ^{3}H(p,γ)^{4}He cross section was measured at 90° from 3 to 18 MeV proton energy at 0° from 4 to 14 MeV, and complete angular distributions were taken at 10.5, 12, and 14 MeV. The c.m. angular distributions are consistent with $A + B\sin^2\theta + C\sin^2\theta\cos\theta + D\sin^2\theta\cos^2\theta$ as expected for mixed E1 and E2 radiations. Using our and other results, the integrated ^{4}He(γ,p)^{3}H cross section, computed from the reciprocity relation, is decomposed into E1 and E2 contributions up to $E_\gamma \approx 30$ MeV. Extrapolations for the relative contributions are proposed up to $E_\gamma \approx 150$ MeV. After removal of kinematic factors, the E1 contribution is shown to be resonant, but the E2 contribution is not resonant. Interpretation of the coefficient ratio A/B by Crone and Werntz shows that M2 contributions have an important effect on the magnitude of this coefficient. If the ^{4}He level scheme of Werntz and Meyerhof is accepted, the singlet strength in the two T = 1, 1$^-$ levels appears to lie predominantly in the lower level, in contrast to findings from ^{3}He(p,p) scattering and polarization measurements. (auth)

49702 MICROSCOPIC ANALYSIS OF THE (^{3}He,t) CHARGE EXCHANGE REACTION ON N = 28 EVEN NUCLEI AND THE TWO-BODY INTERACTION. Kossanyi-Demay, P.; Roussel, P.; Faraggi, H.; Schaeffer, R. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys.; A148: 181-210(1970).

Analysis of published (^{3}He,t) data on N = 28 targets was done using the model proposed by Madsen: the (^{3}He,t) reaction is treated as a (p,n) direct, one-step reaction using a conventional effective charge exchange force, which takes the matter distribution of the projectile into account. The results through several radial shapes (Yukawa, Gaussian, Woods-Saxon and its derivative) for this ^{3}He-nucleon interaction were compared. Simple shell-model structure was assumed for the lower final states. For natural parity states, good fits were obtained for the angular distributions, but the effective strength needed for the force increased strongly for large transferred angular momenta when reasonable radial shapes were used. For unnatural parity states, the wrong value of the orbital angular momentum transfer dominates in the microscopic calculations so that no good fits can be obtained. This analysis of a large variety of simple states with different spins permits the conclusion that the model used to describe the reaction has to be improved, either by including noncentral forces, or to account for the microscopic structure by including noncentral forces and by a proper description of

the antisymmetrization between projectile and target nucleons. Two-step processes may also be needed. (auth)

49703 EVIDENCE FOR A LOW-ENERGY RESONANCE IN THE THREE-NEUTRON SYSTEM. Sperinde, J.; Fredrickson, D.; Hinkins, R.; Perez-Mendez, V.; Smith, B. (Univ. of California, Berkeley). Phys. Lett.; 32B: 185-6(22 Jun 1970).

A study of the double charge-exchange reaction $\pi^- + {}^3He \rightarrow \pi^+ + 3n$ indicates resonant behavior in the three-neutron system within a few MeV of threshold. The three-neutron data from this experiment are in good agreement with the resonant behavior obtained in the three-proton system in another reaction. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 48284, 49337, 49396, 49398, 49646, 49692, 49693, 49796, 49801, 49802, 49822, 49845, 49880, 49881, 49885, 49919, 49928, and 49968.

49704 (NP-18438) STUDY OF THE EXCITED LEVELS OF BORON 10 IN THE 7.5 MeV REGION. Bontemps, Andre (Grenoble Univ. (France). Faculte des Sciences). 1970. 77p. (In French). Dep. CFSTI (U. S. Sales Only).
Thesis.

In order to establish a better understanding of the excited levels of ^{10}B between 7.35 and 7.8 MeV, the reactions $^9Be(p,p)^9Be$, $^9Be(p,\alpha_0)^6Li$, and $^9Be(p,\gamma)^{10}B$ were studied using proton energies between 0.6 and 1.5 MeV. It was shown that the excitation curve of $^9Be(p,p)$ could be taken into account by introducing p and d waves into the analysis; the $^9Be(p,\alpha)$ reaction involved two mechanisms: a compound nucleus mechanism and a direct mechanism. (France)

49705 (NP-18448) STUDY OF NUCLEON TRANSFER REACTIONS BETWEEN HEAVY IONS. Liu, Michel (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 65p. (In French). Dep. CFSTI (U. S. Sales Only).
Thesis.

The angular distributions of particular transfer reactions at various incident energies were studied. The reactions $^{11}B(^{14}N,^{13}C)^{12}C$ and $^{11}B(^{14}N,^{15}O)^{10}Be$ were studied at 40, 77 and 113 MeV. The reactions $^{12}C(^{14}N,^{13}N)^{13}C$ and $^{12}C(^{14}N,^{13}C)^{13}N$ were studied at 77 MeV, and the reactions $^{13}C(^{12}C,^{13}C)^{12}C$ and $^{11}B(^{12}C,^{11}B)^{12}C$ at 87 MeV. The results obtained were explained using DWBA to describe the reaction mechanisms. The validities of the different approximations proposed for calculating the differential cross sections of the interaction models were compared. In the first approximation, the transfer of a nucleon was shown to be a direct-interaction mechanism leaving the cores inert. To explain the shape of the distribution, it is necessary to treat the reaction as a three-body problem. The nuclear information which can be obtained from angular distribution measurements was examined. (France)

49706 (RT/FI-(70)18) SCATTERING CROSS SECTION MEASUREMENTS WITH A SOLID STATE NEUTRON SPECTROMETER. Frittelli, L.; Vinci, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1 Apr 1970. 33p. (In Italian). Dep. CFSTI (U. S. Sales Only).

A solid-state neutron spectrometer was used to measure the elastic and inelastic scattering cross sections in natural silicon and magnesium at 3.24 MeV neutron energy. The values obtained from the processed experimental data are in good agreement with those of literature. (auth)

49707 (SINP-TH-68-4) DIRECT (p,n) REACTION IN ^7Li. Mahalanabis, Jayanti (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). [nd]. 27p. Dep. CFSTI (U. S. Sales Only).

The (p,n) reaction in ^7Li at 94 MeV was studied in the impulse approximation. The differential cross section exciting the isobaric analog state and 0.431-MeV state in ^7Be are obtained using the L-S coupled shell model wave functions. Fairly good shape agreement with the available experimental results is obtained. These results are discussed as a mode of investigating the model wave functions used together with the inelastic proton scattering to the 0.478-MeV state in ^7Li, where the small-angle results as predicted by the theory appear to be in conflict with the experimental data. Need for more experimental data at small angles for these reactions is stressed. (auth)

49708 THE $^{19}F(d,\alpha)^{17}O$ REACTION AND THE 2I + 1 RULE. Liu, Yuen-chung; Hou, Wen-sou; Chang, Chuen (National Tsing Hua Univ., Hsinchu, Taiwan). Chin. J. Phys. (Taiwan); 7: 63-70 (Oct 1969).

The $^{19}F(d,\alpha)^{17}O$ reaction was studied in the bombarding energy range E_d = 1.6 to 2.1 MeV. The integrated cross sections of four α groups are compared with the 2I + 1 rule where I is the spin of the residual nucleus. The calculated total cross sections based on the statistical compound nucleus theory are compared directly with experimental ones and a better agreement is obtained. (auth)

49709 LOW ENERGY SCATTERING CROSS SECTION OF ^{10}B. Asami, A.; Moxon, M. C. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 24: 85-96(Apr 1970).

Measurements of the scattering cross section of ^{10}B relative to that of carbon were made in the energy range 1-120 keV using ^6Li glass neutron detectors on a 50 m flight path of the Harwell electron linac time-of-flight spectrometer. The measurements carried out at angles of 39, 65, 120, and 144° to the incident neutron beam showed no significant differences between the differential scattering cross section measured at the four angles. The total scattering cross section of ^{10}B decreases from a value of 2.97 b at 127 keV to 2.23 at 10 keV, below which it remains constant at an average value of 2.23 ± 0.06 b. This value, when compared with the constant term of 1.95 ± 0.1 b obtained from other total cross section measurements, indicates a deviation from the 1/v law for the absorption cross section of (-0.28 ± 0.12) b. (auth) (UK)

49710 (p,pα) AND (α,2α) REACTIONS ON ^6Li AND ^7Li AT 60 MeV. Jain, Mahavir; Roos, P. G.; Pugh, H. G.; Holmgren, H. D. (Univ. of Maryland, College Park). Nucl. Phys.; A153: 49-81(1970).

An investigation of the alpha cluster knockout reaction was made by studying the $^{6,7}Li(p,p\alpha)^{2,3}H$ and the $^{6,7}Li(\alpha,2\alpha)^{2,3}H$ reactions using approximately 60 MeV incident particles. Both energy sharing and angular correlation experiments were performed near a quasi-free angle pair and alpha cluster momentum distributions $|\phi(q)|^2$ extracted by means of the plane wave impulse approximation. The momentum distributions extracted from the (p,pα) reactions for the two experimental techniques are in good agreement and have the shape expected for the knockout of an L = 0 α-cluster from ^6Li and an L = 1 α-cluster from ^7Li. The shapes of the $|\phi(q)|^2$ extracted from the (α,2α) energy sharing experiments are in reasonably good agreement with the (p,pα) results; the agreement in magnitude being within the experimental uncertainties. However, the angular correlation results for $^7Li(\alpha,2\alpha)^3H$ show large discrepancies, casting doubt on the analysis of the (α,2α) reaction with the normal impulse approximation. A discussion of the effects of various methods of making the quasi-free approximation is given. (auth)

49711 OPTICAL-MODEL ANALYSIS FOR ^3He ELASTIC SCATTERING BY THE NUCLEI ^7Li, ^{12}C, ^{19}F, ^{23}Na, AND ^{35}Cl. Scheklinski, G.; Strohbusch, U.; Goel, B. (Univ., Freiburg i. B.). Nucl. Phys.; A153: 97-108(1970).

Angular distributions for ^3He elastic scattering by ^7Li, ^{12}C, ^{19}F, ^{23}Na and ^{35}Cl were measured at 11 MeV and analyzed in terms of the optical model. Good fits were obtained in all cases. A systematic study of ambiguities was carried out. No conclusions concerning the necessity for a spin-orbit term in the optical-model potential could be drawn from the experimental results. The influence of uncertainties in the absolute cross sections on the optical parameters was studied. (auth)

49712 STUDY OF THE REACTION $^{11}B(^3He,\gamma_0)^{14}N$ IN THE ENERGY RANGE $E_{^3He}$ = 0.9 TO 2.6 MeV. Black, J. L.; Caelli, W. J.; Davidson, W. F.; Watson, R. B. (Australian National Univ., Canberra). Nucl. Phys.; A153: 233-34(1970).

Excitation functions for the reaction $^{11}B(^3He,\gamma_0)^{14}N$ have been measured at 0° and 90° in 25 keV steps for ^3He energies between 0.9 and 2.6 MeV. The γ-ray detector used was a 23.8 × 25.4 cm NaI(Tl) crystal. When the yield from the reaction is divided by the barrier penetration factor a broad resonance is seen at both angles, which peaks at a ^3He energy of 1.4 MeV, corresponding to an excitation energy in ^{14}N of 21.8 MeV. The $(^3He,\gamma)$ excitation functions are compared with other reaction channels leading to the same excitation region in ^{14}N. Angular distributions were measured at six ^3He energies and were found to be approximately isotropic. Possible spin assignments are discussed. (auth)

49713 $J^\pi = 1^+$ ISOSPIN DOUBLET IN ^{12}C. Reisman, F. D.; Connors, P. I.; Marion, J. B. (Univ. of Maryland, College Park). Nucl. Phys.; A153: 244-54(1970).

Isospin mixing in the $J^\pi = 1^+$ levels in ^{12}C at 12.71 and 15.11 MeV was studied by means of the $^{13}C(^3He,\alpha)^{12}C$ reaction. The relative α-particle and γ-ray decay widths were measured for both levels and the α-decay of the 15.11 MeV state was observed for the first time. Since the total width of the 12.71 MeV level is not known,

these data were used along with theoretical calculations to establish the isospin mixing of the two states. The intensity of isospin mixing is 1–3%. (auth)

49714 ACCURATE EXCITATION ENERGIES OF ^{11}B AND ^{11}C. Browne, C. P.; Maille, G.; Tarara, R.; Duray, J. R. (Univ. of Notre Dame, Ind.). Contract 1625(05). Nucl. Phys.; A153: 289–300(1970).

Excitation energies of the first five states in ^{11}B were measured with the $^{12}C(d,\alpha)^{11}B$ reaction. Values obtained are 2125.4 ± 1.4 keV, 4444.5 ± 1.6 keV, 5020.2 ± 1.9 keV, 6745.9 ± 3.4 keV and 6795.7 ± 3.0 keV. These values agree with results obtained previously in this lab with the $^{10}B(d,p)^{11}B$ and $^{9}Be(^{3}He,p)^{11}B$ reactions. Hence no effect on the measured excitation energies of the charge of the incoming and outgoing particles was observed. Previous values are altered up to 1.3 keV by recalculation to correct for change in recoil mass with excitation. Corrected values are given. The measured ground state Q-value is 5166.6 ± 2.5 keV and agrees with the value calculated from mass tables. Excitation energies of ^{11}C were measured with the $^{12}C(^{3}He,\alpha)^{11}C$ reaction using Tandem Accelerators and broad-range spectrographs. The excitation energy of the first state was confirmed by measurements with the $^{10}B(^{3}He,d)^{11}C$ reaction. The results agree and give average values of 2000.6 ± 0.9, 4318 ± 1.2, 4804.2 ± 1.2, 6339.2 ± 1.4, 6478.2 ± 1.3, 6904.8 ± 1.4, 7499.7 ± 1.5 and 8104.5 ± 1.7 where the uncertainties listed are statistical only and do not include the uncertainty in the calibration energy. A systematic discrepancy with values listed in a recent summary article is found. (auth)

49715 REACTION $^{6}Li(^{6}Li,\alpha)2\alpha$ BETWEEN 4 AND 24 MeV. Frois, B. (CEN, Bordeaux-Gradignan, France); Marquez, L.; Quebert, J. L.; Scheurer, J. N.; Laugier, J. P.; Gruber, G.; Heinicke, E.; Meier-Ewert, K. Nucl. Phys.; A153: 377–88(1970).

The reaction $^{6}Li(^{6}Li,\alpha)2\alpha$ was studied from 4 to 24 MeV. Previous studies at low energies resulted in the hypothesis of a quasimolecular state in the ^{6}Li–^{6}Li system which explains the broad continuum in the α-particle spectra. The predictions of this hypothesis, that the continuum peak should both broaden and diminish at higher energies, are consistent with the present experiment. (auth)

49716 SCATTERING OF MEDIUM-ENERGY PIONS FROM CARBON AND OXYGEN. Wilkin, C. (University Coll., London). Lett. Nuovo Cim.; 4: 491–4(12 Sep 1970).

Cross sections and angular distributions for the elastic scattering of negative pions from ^{12}C in the region of the first ($\frac{3}{2}$, $\frac{3}{2}$) πN resonance at T_π = 120 to 280 MeV and from ^{16}O at T_π = 270 MeV are compared with those obtained using the Glauber approximation. It is found that the theory and experiment are in fairly good agreement, although little explanation is given for this agreement. (L.B.S.)

49717 MONOPOLE SUM RULE AND THE ELECTROEXCITATION OF THE FIRST EXCITED STATE IN ^{16}O. Kao, Ellen Ih-liang; Fallieros, Stavros (Brown Univ., Providence). Phys. Rev. Lett.; 25: 827–8(21 Sep 1970).

A sum rule is discussed for the isoscalar part of form factors describing monopole excitations of nuclear levels by inelastic electron scattering. A model is subsequently introduced for the form factor of the first excited state in ^{16}O which compares reasonably well with recent experimental data. (auth)

49718 MEASUREMENTS OF ^{43}K, ^{44}K, AND ^{45}K GAMMA RAYS. Larson, R. E.; Gordon, C. M. (Naval Research Lab., Washington, D. C.). Radiochim. Acta; 13: 61–2(1970).

^{43}K, ^{44}K, and ^{45}K were produced by photonuclear reactions on enriched isotopes of ^{44}Ca, ^{46}Ca, and ^{48}Ca. Evaluation of the gamma spectra yielded the energy of the gamma rays. Gamma rays at 220.6, 372.9, 396.8, 593.4, 617.3, 989.9, 1021.8, and 1394.2 keV were assigned to ^{43}K. For ^{44}K the values 651.8, 1026.6, 1127.2, 1157.0, 1499.6, 2151.0, 2518.8, 3397.0, 3661.4, and 4862 keV were found. Gamma rays at 174.3, 1280.7, 1705.6, 2354.2, and 2598.8 keV were assigned to ^{45}K. (auth)

49719 SPIN EFFECTS IN PION CHARGE-EXCHANGE SCATTERING ON NUCLEI. Charlton, L.; Eisenberg, J. M. (Univ. of Virginia, Charlottesville, Va.). Can. J. Phys.; 47: 236–8(15 Jan 1969).

The differential cross section for pion charge–exchange scattering from ^{12}C was calculated using sum-rule techniques in order to investigate possible spin-dependent effects in proton–neutron correlations. The resulting cross section prove to be quite insensitive to such effects under the usual assumptions concerning the correlation function. (auth) (Canada)

49720 INTERPRETATION OF HEAVY ION ELASTIC SCATTERING. Blair, J. S. (Univ. of Washington, Seattle. Univ. of Surrey, Guildford, Eng.). pp 1–26 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The classical description of heavy ion scattering is reviewed and deviations therefrom discussed. The elastic scattering of alpha particles, ^{19}F, and ^{16}O by light targets is considered. A feature of optical analyses is a preference for shallow real potentials, thus implying relatively little refraction at the higher bombarding energies. (44 references) (M.C.G.)

49721 QUASIMOLECULAR HEAVY ION INTERACTIONS. Bromley, D. Allan (Yale Univ., New Haven). Contract AT (30-1)-3223. pp 27–59 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The existence in nuclear physics of quasimolecular interactions is discussed. Heavy ion (^{16}O and ^{12}C) elastic scattering excitation functions are given. Interaction potentials and quasimolecular resonances in $^{16}O + ^{16}O$, $^{14}N + ^{14}N$, and $^{12}C + ^{12}C$ systems are considered. (56 references) (M.C.G.)

49722 AMBIGUITIES IN THE IMAGINARY PART OF THE HEAVY-ION OPTICAL POTENTIAL. Maher, J. V. (Argonne National Lab., Ill.); Siemssen, R. H.; Sachs, M.; Weidinger, A.; Bromley, D. A. pp 60–4 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

An investigation was made of the ambiguity in the imaginary part of the potential for cases in which there is pronounced structure both in the angular distributions and excitation functions and of the energy dependence of the ambiguity. $^{16}O + ^{16}O$ elastic scattering was used as a test case. The continuous ambiguity was seen only in the imaginary potential, whereas discrete ambiguities were found for the real potential. (M.C.G.)

49723 OXYGEN ELASTIC SCATTERING FROM THE EVEN-MASS MAGNESIUM AND SILICON ISOTOPES. Siemssen, R. H.; Fortune, H. T.; Richter, A.; Yntema, J. L. (Argonne National Lab, Ill.). pp 65–8 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg Germany. See CONF-690707.

Elastically scattered ^{16}O ions were detected in coincidence with the recoiling target nuclei in a completely computer-controlled scattering chamber. The targets were isotopically enriched targets of ^{24}Mg, ^{26}Mg, ^{28}Si, and ^{30}Si, evaporated onto thin carbon backings. The bombarding energy range was 30 to 53 MeV at c.m. angles of 50, 60, 70, 80, 90, and 100°. The differential cross sections varied by as much as three orders of magnitude in both the angular distributions and the excitation functions over the angular and energy range studied. The structure was much more pronounced for the scattering off ^{26}Mg than off ^{24}Mg. (M.C.G.)

49724 ELASTIC SCATTERING OF ^{16}O BY ^{16}O FROM 30 TO 50 MeV. Fortune, H. T.; Richter, A.; Siemssen, R. H.; Tippie, J. W. (Argonne National Lab., Ill.). pp 69–71 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A study of $^{16}O + ^{16}O$ elastic scattering was initiated using an ^{16}O beam at energies between 30 and 50 MeV. The excitation function resembled the optical-model predictions much more closely than do the corresponding $^{16}O + ^{16}O$ data. (M.C.G.)

49725 ELASTIC SCATTERING OF ^{6}Li ON ^{6}Li. Morrison, G. C.; Fortune, H. T.; Siemssen, R. H. (Argonne National Lab., Ill.). pp 72–5 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A study of the $^{6}Li + ^{6}Li$ elastic scattering was carried out at the Argonne FN tandem accelerator, which makes use of a ^{6}Li beam at laboratory energies between 9 and 34 MeV. Excitation functions were measured in 250-keV steps at angles 40 to 90° in the center-of-mass system. Detailed angular distributions were measured at 12, 20, and 28 MeV. (M.C.G.)

49726 ANGULAR MOMENTUM MATCHING IN THE OPTICAL MODEL. Chatwin, R. A.; Eck, J. S.; Richter, A.; Robson, D. (Florida State Univ., Tallahassee). pp 76–9 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

When a cutoff in l of the potential W(r) was introduced into the optical model, significant improvements in the description of elastic scattering resulted. This physical situation can be put into the optical model by giving the absorption on l-dependence: $W(r) \rightarrow W(r)/\{1 + \exp[(l - lc)/\Delta l]\}$. It is shown how to estimate a priori the two new parameters, lc and Δl. The power of the new model is illustrated with a calculation of a backward glory. (M.C.G.)

49727 ANALYSIS OF HEAVY ION ELASTIC SCATTERING USING AN EXTENDED OPTICAL MODEL. Eck, J. S.; Chatwin, R. A.; Eberhard, K. A.; Lasalle, R. A.; Richter, A.; Robson, D. (Florida State Univ., Tallahassee). pp 80–4 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

An extension to the optical model that includes an l-dependence in the absorptive potential was used to analyze the elastic scattering of $^{16}O + ^{16}O$ and $^{16}O + ^{40}Ca$. (M.C.G.)

49728 SHAPE OF ^{24}Mg BY SCATTERING OF 36 MeV ^{16}O. Eck, J. S.; Thompson, W. J. (Florida State Univ., Tallahassee). pp 85–8 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The inelastic scattering of heavy ions (^{16}O) of short wavelength and in the neighborhood of the Coulomb barrier revealed the surface features of ^{24}Mg. The resolution of higher multipole orders would probably require including the finite size of the ^{16}O and the possibility of its internal excitation. Within an alpha-cluster description of the energy levels of ^{24}Mg a bi-pyramidal structure is favored. The β_2 and β_4 values obtained seem to be consistent with such a description. In the present analysis using the coupled-channels calculation, reorientation effects without shape changes within the $0^+ - 2^+ - 4^+$ rotational band were accounted for. The relative simplicity of measurement and interpretation suggests the general applicability of this technique for the mensurement of nuclear shapes. (auth)

49729 ELASTIC SCATTERING IN THE $^{14}N + ^{14}N$ SYSTEM. Reilly, W.; Wieland, R.; Gobbi, A.; Sachs, M. W.; Bromley, D. A. (Yale Univ., New Haven). pp 93–4 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Elastic scattering excitation functions for the $^{14}N + ^{14}N$ system were examined in the energy range $17 \leq E_{c.m.} \leq 30$ MeV at angles of 50 to 90°. In contrast to both the $^{16}O + ^{16}O$ and the $^{12}C + ^{12}C$ data, the $^{14}N + ^{14}N$ excitation functions showed markedly reduced fine and intermediate structure. At the same time, gross structure definitely appeared. (M.C.G.)

49730 ELASTIC SCATTERING IN THE $^{12}C + ^{12}C$ SYSTEM. Reilly, W.; Wieland, R.; Gobbi, A.; Sachs, M. W.; Maher, J. V.; Mingay, D.; Siemssen, R. H.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. pp 95–8 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Studies on the $^{12}C + ^{12}C$ system were carried out. Five excitation functions at 50 to 90° were measured in the energy range from 13.5 to 37.5 MeV. The statistical fluctuation phenomena that characterized the $^{12}C + ^{12}C$ data at lower energies were largely damped. A periodic intermediate structure emerged with a width increasing systematically from 0.6 to some 1.2 MeV in the range studied. (M.C.G.)

49731 INELASTIC SCATTERING IN THE $^{12}C + ^{12}C$ SYSTEM. Gobbi, A.; Sachs, M. W.; Reilly, W.; Wieland, R.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. pp 99–100 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). N New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Inelastic scattering with negative Q values of 4.43 and ≈9 MeV was examined in the $^{12}C + ^{12}C$ system for $27 \leq E_{Lab} \leq 75$ MeV at 25°. The intensity of the mutual quadrupole excitation was comparable to that of the single quadrupole excitation. (M.C.G.)

49732 MODIFIED McINTYRE MODEL ANALYSIS OF HEAVY ION ELASTIC SCATTERING AT MEDIUM ENERGIES. Heib, H.-D.; Voit, H.; Ischenko, G.; Reichardt, W. (Univ., Erlangen, Ger.). pp 101–4 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The angular distribution of ^{14}N on ^{12}C for $E_{lab} = 22.5$ MeV was measured and found to exhibit remarkable structure at large angles. Other heavy ion angular distributions were examined using the modified McIntyre model. (M.C.G.)

49733 SEARCH FOR STRUCTURE IN EXCITATION FUNCTIONS OF THE REACTIONS $^{12}C + ^{12}C$ AND $^{14}N + ^{10}B$. Ischenko, Gg.; Reichardt, W.; Voit, H.; Heib, H.-D. (Univ., Erlangen, Ger.). pp 105–9 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A search for structures in excitation functions of the reactions ^{12}C on ^{13}C and ^{14}N on ^{10}B in different channels was undertaken. Both measurements of the compound reactions were performed below the top of the Coulomb barrier ($E_{lab} < 15.5$ MeV and $E_{lab} < 18.5$ MeV). The expected structures were strongly damped. (M.C.G.)

49734 ON THE RELATIVE IMPORTANCE OF DIRECT AND EXCHANGE AMPLITUDES IN ELASTIC SCATTERING OF NON-IDENTICAL HEAVY IONS. Clarkson, R. G.; Gutbrod, H. H.; Brentano, P. v.; Bock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ., Marburg, Ger.). pp 110–12 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Calculations were made of the elastic scattering cross section, from the optical model, as a function of the momentum transfer q and the incident momentum k. It is proposed that heavy ion elastic scattering cross sections be considered as a function of q and k. (M.C.G.)

49735 SUB-COULOMB TRANSFER REACTIONS. Goldfarb, L. J. B. (Univ. of Manchester, Eng.). pp 115–27 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The application of the distorted-wave Born approximation to transfer reactions was studied. Both neutron and proton transfer in heavy ion reactions were considered. (M.C.G.)

49736 TRANSFER REACTIONS INVESTIGATED AT ORSAY. Jacmart, J. C.; Liu, M.; Roynette, J. C.; Caverzasio, C.; Pougheon; F.; Stephan, C.; Riou, M.; von Oertzen, W. (Institut de Physique Nucleaire, Orsay, France). pp 128–39 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The experimental apparatus, investigation program, transfer reaction mechanisms, and multinucleon transfer are discussed. Angular distributions were measured for two transfer reactions leading to definite states at three energies corresponding to different mismatch conditions. Different stripping reactions leading to excited levels of ^{16}O were investigated. (M.C.G.)

49737 HEAVY ION TRANSFER REACTIONS IN THE REGION OF THE COULOMB BARRIER. Barker, P. H.; Huber, A.; Knoth, H.; Matter, U.; Marmier, P. (Laboratorium fuer Kernphysik, Zurich). pp 152–5 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Angular distributions of heavy ion transfer reactions were measured at energies near the Coulomb barrier. The reactions studied include: ^{16}O ion reactions with ^{12}C and ^{9}Be; ^{12}C ion reactions with ^{9}Be and ^{12}C; ^{19}F ion reactions with ^{10}Be; and ^{18}O ion reactions with ^{9}Be, ^{10}B, ^{12}C, ^{12}C, and ^{18}O. (M.C.G.)

49738 NUCLEAR SPECTROSCOPY WITH HEAVY-ION-INDUCED TRANSFER REACTIONS. von Oertzen, W.; Bohlen,

H. G.; Gutbrod, H. H.; Hildenbrand, K. D.; Voos, U. C.; Bock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ., Marburg, Ger.). pp 156-70 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Proton transfer between states with known structure was studied in heavy-ion reactions. Several projectiles were used (^{10}B, ^{16}O, ^{19}F) to study the population of the excited states of ^{16}O. The elastic scattering of ^{10}B, ^{11}B, ^{16}O, ^{19}F and ^{12}C was measured at several energies. The proton transfer ^{12}C(^{11}B,^{12}C)^{11}B leading to states of ^{11}B and ^{12}C was studied at 28 MeV and the proton transfer ^{12}C(^{19}F,^{20}Ne)^{11}B was studied at 40, 60, and 68 MeV. The population of the states of ^{15}N was studied in the reaction ^{12}C(^{19}F,^{16}O)^{15}N. (M.C.G.)

49739 REACTIONS WITH TRANSFER OF TWO PARTICLES. Rotter, I. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). pp 185-6 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

It is shown that the two transferred nucleons do not form of necessity an intermediate deuteron-like state. The amplitude of the one-step reaction with transfer of two nucleons was calculated. (M.C.G.)

49740 SYSTEMATICS OF NUCLEON TUNNELLING IN HEAVY ION REACTIONS. Buttle, P. J. A.; Goldfarb, L. J. B. (Univ. of Manchester, Eng.). pp 197-201 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A systematic treatment of neutron tunnelling in heavy-ion reactions using the analytic form of the DWBA amplitude is discussed. A careful treatment involves two Coulomb parameters corresponding to the incident and final channels. Reactions were considered in which the neutron is transferred from a weakly bound state to a tightly bound final ground state. Proton transfer is also considered. (M.C.G.)

49741 INTERACTION INDUCED BY THE RESONANT EXCHANGE OF NUCLEONS BETWEEN TWO IDENTICAL NUCLEAR CORES. von Oertzen, W. (Institut de Physique Nucleaire, Orsay, France. Max-Planck Institut fuer Kernphysik, Heidelberg). pp 202-5 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The possible effects of the exchange of particle c between the cores A and A′ on the elastic scattering process are discussed. The elastic scattering is assumed under the influence of the exchange interaction in a potential model for the case that the core has spin zero and angular momentum transfer zero. (M.C.G.)

49742 DIRECT REACTION MODELS IN HIGH ENERGY TRANSFER PROCESSES. Greider, K. R. (Univ. of California, Davis). pp 217-30 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The several theories of heavy-ion transfer reactions available today are outlined. Topics covered include: direct reaction theory, distorted wave method, approximations and models in DWBA calculations, analysis of the two-body diffraction model and the finite range models, recoil effects, the distorted-wave Born model, and other open questions. (M.C.G.)

49743 STUDY OF LITHIUM-INDUCED REACTIONS AT THE KURCHATOV ATOMIC ENERGY INSTITUTE. Ogloblin, A. A. (Kurchatov Atomic Energy Inst., Moscow). pp 231-62 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The three main mechanisms in lithium-induced reactions are: dissociation processes, complicated direct processes, and cluster-transfer mechanisms. Reactions studied include: alpha transfer (^{6}Li,d) and (^{7}Li,t) reactions, deuteron transfer (^{6}Li,α) reactions, triton transfer (^{7}Li,α) reactions, (^{6}Li,t) reactions, lithium ion dissociation processes, and elastic scattering. Alpha cluster states, cluster states at high excitation energies, threshold cluster states, and multicluster states are considered. (M.C.G.)

49744 REPORT ON SOME LITHIUM REACTION STUDIES. Middleton, Roy (Univ. of Pennsylvania, Philadelphia). pp 263-76 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A variety of ^{6}Li- and ^{7}Li-induced reactions were studied with emphasis on the (^{6}Li,d) and (^{7}Li,t) alpha transfer reactions. Most of the studies were performed on relatively light target nuclei ($A \leq 40$) at incident energies in the range 12 to 24 MeV. The majority of the measured angular distributions suggests that both the (^{6}Li,d) and (^{7}Li,t) reactions proceed predominantly via a direct mode involving the transfer of an α particle, the (^{7}Li,t) reaction displaying somewhat stronger direct characteristics. Detailed studies on ^{20}Ne are presented. (M.C.G.)

49745 LABORATORY REPORT ON NUCLEAR REACTIONS INDUCED BY LITHIUM NUCLEI. Bethge, Klaus (Univ., Heidelberg. Univ. of Pennsylvania, Philadelphia). pp 277-88 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The reactions of ^{6}Li and ^{7}Li with ^{12}C and ^{7}Li with ^{13}C were studied. The reaction mechanism and nuclear structure are discussed. (M.C.G.)

49746 LABORATORY REPORT ON PRELIMINARY RESULTS OBTAINED WITH A ^{7}Li BEAM. Cotton, E. (CEN, Saclay, France). pp 289-92 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Studies were made of alpha transfer by the (^{7}Li,t) reactions and other possible transfers. The (^{7}Li,t) and (^{7}Li,α) reactions on ^{12}C were investigated along with (^{7}Li,t) reactions on ^{38}A, ^{40}Ca, ^{44}Ca, and ^{54}Fe. (M.C.G.)

49747 ALPHA-TRANSFER REACTION ^{12}C(^{7}Li,t)^{16}O. Brommundt, G. (Univ., Heidelberg); Ritter, H. G.; Bock, R.; Puehlhofer, F. pp 293-6 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A DWBA analysis and its problems for the (^{7}Li,t) reaction on ^{12}C are reported. The four-particle correlations in the states of the final nucleus ^{16}O were studied. Angular distributions were determined. (M.C.G.)

49748 ^{12}C(^{6}Li,t)^{16}O REACTION AT 20 MeV. Bassani, G.; Kruse, T. H.; Saunier, N.; Souchere, G. (CEN, Saclay, France). pp 300-2 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

States in ^{16}O up to an excitation energy of 16.9 MeV were observed from the bombardment of ^{12}C with a 20-MeV ^{6}Li beam. Angular distributions were obtained from 15 to 105°. States of quite different nature were excited with considerable strength, but certain states appeared to be preferentially excited. (M.C.G.)

49749 Li-INDUCED REACTIONS ON ^{12}C. Comfort, J. R.; Fortune, H. T.; Morrison, G. C.; Zeidman, B. (Argonne National Lab., Ill.). pp 303-6 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Beams of ^{6}Li at 29.0 MeV and ^{7}Li at 31.5 MeV were used to bombard a ^{12}C target. The reactions studied included: (^{6}Li,α), (^{7}Li,α), (^{6}Li,d), and (^{7}Li,t). (M.C.G.)

49750 (^{3}He,^{7}Be) REACTION IN LIGHT NUCLEI. Fortune, H. T.; Zeidman, B. (Argonne National Lab., Ill.). pp 307-10 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The 36-MeV ^{3}He beam was used to bombard isotopically enriched targets of ^{10}B, ^{11}B, ^{12}C, ^{13}C, ^{24}Mg, ^{26}Mg, ^{28}SiO$_2$, and ^{48}CaF$_2$. Cross sections and angular distributions were determined. (M.C.G.)

49751 INVESTIGATION OF α-TRANSFER ON LIGHT NUCLEI BY THE (d,^{6}Li) REACTION. Gutbrod, H. H.; Yoshida, H.; Bock,

R. (Max-Planck-Institut fuer Kernphysik, Heidelberg Univ., Marburg, Ger.). pp 311-14 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Angular distributions and absolute cross sections were measured for (d,^{6}Li) reactions on ^{10}B, ^{11}B, ^{12}C, ^{16}O, ^{19}F, and ^{40}Ca at an incident deutron energy of 19.5 MeV. Finite-range DWBA calculations were performed to analyze the data. The diffraction structure and the forward peak in the angular distribution of the $0^+ - 0^+$ transition show that the reaction mechanism is mainly direct. (M.C.G.)

49752 GROUND STATE AND POSITIVE PARITY 4p-4h STATES IN ^{16}O POPULATED BY α-PICK-UP AND α-STRIPPING REACTIONS. Duhm, H. H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 315-18 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A qualitative discussion of α-stripping and α-pick-up reactions leading to the final nucleus ^{16}O is given. The forward-angle spectra for the reactions ^{12}C(^{7}Li,t)^{16}O, ^{20}Ne(d,^{6}Li)^{16}O, and ^{20}Ne(^{3}He,^{7}Be)^{16}O are compared. The most obvious difference between the α-stripping and α-pick-up spectra was the general decrease of cross section with increasing excitation energy for pick-up and increase in cross section for stripping. (M.C.G.)

49753 (^{3}He,^{7}Be) GROUND-STATE TRANSITIONS ON ^{12}C, ^{16}O, ^{20}Ne, ^{28}Si, AND ^{40}Ca. Detraz, C.; Duhm, H. H.; Hafner, H.; Yoshida, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 319-23 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Data are reported on the $0^+ \rightarrow 0^+$ ground state transitions from A = 4n nuclei, ^{12}C, ^{16}O, ^{20}Ne, ^{28}Si, and ^{40}Ca, in (^{3}He,^{7}Be) reactions. The cross sections for the transition, as measured at the first maximum of the distribution around 20°, experienced a very strong decrease with the target mass number. The angular distributions exhibited diffraction patterns and were strongly forward peaked. This suggested a direct reaction mechanism and the possibility of a distorted wave interpretation. It was concluded that the α-clustering probability may be larger than predicted by the shell model wave functions. (M.C.G.)

49754 NUCLEAR CLUSTERS IN LIGHT NUCLEI. Neudatchin, V. G. (Moscow State Univ.); Wildermuth, K. pp 327-46 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Nuclear theory and cluster representations with applications to light nuclei are discussed. One method of describing bound states and nuclear reactions is to formulate the A-particle Schroedinger equation with the help of the Raleigh-Schroedinger variational method. Nuclear reactions with nucleon clusters are considered. (M.C.G.)

49755 MULTI-CONFIGURATION-HARTREE-FOCK THEORY AND SPECTROSCOPIC FACTORS. Faessler, Amand; Plastino, A. (Univ., Muenster, Ger.). pp 362-3 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A method is proposed that is self-consistent, takes into account all types of correlation, and yields also excited states. A nonlinear system of 4 coupled equations is obtained, which must be solved by an iterative procedure. (M.C.G.)

49756 REORIENTATION EFFECT IN MULTIPLE COULOMB EXCITATION. Smilansky, Uzy (Weizmann Inst. of Science, Rehovoth, Israel). pp 392-414 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The reorientation effect as a method of measuring quadrupole moments of excited nuclear states is reviewed. The semi-classical treatment of the Coulomb excitation process is outlined. The quantal corrections to the semi-classical results and the penetration of the Coulomb barrier and its consequences are discussed. Experimental works are reviewed. (M.C.G.)

49757 REACTIONS PRODUCED IN THE BOMBARDMENT OF ^{28}Si BY ^{16}O. Zioni, J.; Jaffee, A. A.; Friedman, E.; Haik, N.; Schechtman, R. (Hebrew Univ., Jerusalem). pp 693-5 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The reaction products from the bombardment of ^{28}Si with ^{16}O were studied using continuous and chopped incident beams of energy 25 to 32 MeV. Gamma spectra up to about 3.2 MeV and the products ^{43}Sc, ^{42}Ca, ^{42}Sc, and ^{42}Ti were observed. (M.C.G.)

49758 TOTAL EXPERIMENTAL CROSS SECTIONS OF NUCLEAR REACTIONS PRODUCED BY 90 MeV AND 70 MeV ALPHA PARTICLES ON ^{12}C AND ^{14}N TARGET. SOME NUCLEOSYNTHESIS AND NUCLEAR SPECTROSCOPY APPLICATIONS. Jacquot, C.; Jung, M.; Baixeras-Aiguabella, C.; Braun, H.; Schmitt, R.; Cueer, P. (Univ., Strasbourg). pp 701-5 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

About 8000 interactions produced in photographic plates with 90 and 70 MeV α particles from the Karlsruhe accelerator were measured and half of them were univocally identified through the kinematics. All the total cross sections of the channels decaying with no more than one neutral particle were determined. (M.C.G.)

49759 COMMENTS ON THE MOLECULE. Morinaga, H. (Technische Hochschule, Munich). pp 781-3 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Collisions of heavy ions are considered in the one-dimensional Fermi gas model. It is said that the molecule may be understood, probably, as the collective doorway state. (M.C.G.)

49760 ^{12}C(α,γ)^{16}O CAPTURE CROSS SECTION BELOW 3.2 MeV. Jaszczak, Ronald J.; Gibbons, John H.; Macklin, Richard L. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 2: 63-9(Jul 1970).

The ^{12}C(α,γ)^{16}O capture cross section was measured for α-particle energies between 1.86 MeV (σ = 1.1 ± 0.4 nb) and 3.11 MeV (σ = 29 ± 4 nb) using a pulsed ^{4}He$^+$ beam from the ORNL 6-MV Van de Graaff accelerator and a 23- by 30-cm NaI(Tl) crystal viewed by six matched, bialkali photomultiplier tubes. An upper limit was obtained for the capture cross section at E_α = 1.6 MeV. The over-all time resolution (full width at half maximum) of the system for 8-10-MeV pulses due to γ rays is 2.7 nsec. Enriched (99.94%) ^{12}C targets ranging in thickness from 98 to 178 μg/cm^2 were used. Pulses resulting from fast neutrons [from the ^{13}C(α,n)^{16}O reaction] interacting with the NaI(Tl) crystal were further separated from true γ pulses through the use of a new technique based on rise-time distribution differences of the respective neutron- and γ-ray-produced pulses. The face of the crystal (shielded with a 10.2 cm thickness of ^{6}LiH) was 12.2 cm from the target. The astrophysical significance of this reaction in the helium-burning sequence of stellar nucleosynthesis is also discussed. (auth)

49761 EVIDENCE FOR A TENSOR EFFECTIVE TWO-BODY INTERACTION IN THE ^{14}N(p,p') 2.31 MeV EXCITATION. Crawley, G. M. (Michigan State Univ., East Lansing); Austin, S. M.; Benenson, W.; Madsen, V. A.; Schmittroth, F. A.; Stomp, M. J. Phys. Lett.; 32B: 92-4(8 Jun 1970).

The cross section for the excitation of the 2.31 MeV state in ^{14}N by 24.8 MeV protons was measured. Calculations were performed with both central and tensor charge exchange forces. Inclusion of the tensor term greatly improves the agreement between the calculated and the experimental angular distribution. (auth)

49762 INELASTIC SCATTERING OF NUCLEONS BY ^{12}C. Carcabal, Jean (Stanford Univ., Calif.). J. Phys. (Paris); 31: 151-4(Feb-Mar 1970). (In French).

Differential and total cross sections for production of the 4.43-MeV gamma ray in nucleon inelastic scattering by ^{12}C(E < 9 MeV) were evaluated on the basis of the statistical model and of the Satchler formalism. A width fluctuation correction was included. The application of the statistical model to such a light nucleus is only justified by the fact that the computed total cross sections represent the average value of the experimental results and therefore allows estimation of the relative contributions of compound nucleus formation and direct interaction to the cross section. In addition, analysis of the 4.43-MeV γ-ray angular distribution near

resonances permits proposal of spin and parity for 3 unassigned levels in ^{12}C. (auth) (France)

49763 CROSS SECTION FOR $^{12}C(\alpha, \alpha n)^{11}C$ AT 920 MeV. Radin, Jonathan (New York Univ., Bronx). Phys. Rev., C; 2: 793-8(Sep 1970).

Plastic scintillators were exposed in the external 920-MeV α-particle beam at the 184-in. cyclotron at Lawrence Radiation Laboratory. The beam-flux monitor was Ilford 100-μ L4 pellicles. The cross section for $^{12}C(\alpha, \alpha n)^{11}C$ was found to be 49.4 ± 1.8 mb. (auth)

49764 HIGH RESOLUTION MEASUREMENTS OF THE TOTAL NEUTRON CROSS SECTIONS OF NITROGEN AND IRON. Carlson, A. D.; Cerbone, R. J. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng.; 42: 28-40(Oct 1970).

The total neutron cross sections of nitrogen and iron have been measured with high resolution (0.035 nsec/m) in the neutron energy range from 0.5 to 9.0 MeV. The nitrogen measurements have provided evidence that a recently reported discrepancy in the total nonelastic cross section is not a result of errors in the total neutron cross section. The iron cross section obtained was found to be in best agreement with the recent Karlsruhe data with respect to the positions and presence of structure; however, the present measurements have revealed cross sections in the valleys which are lower. Comparisons are made of the present measurements on nitrogen and iron with previous measurements. (auth)

49765 DO THE GROUND STATE ROTATIONAL BANDS OF ^{8}Be AND ^{20}Ne CUT OFF? Goode, P. (Univ. of Rochester, N. Y.); Wong, S. S. M. Phys. Lett.; 32B: 89-91(8 Jun 1970).

The ground state rotational bands of ^{8}Be and ^{20}Ne are calculated microscopically to determine whether the band cut-off at angular momentum is higher than the allowed shell model values of 4^+ and 8^+ respectively. (auth)

49766 STUDY OF RESONANT STATES IN ^{13}C BY SCATTERING OF FAST NEUTRONS ON ^{12}C. Deconninck, G. (Univ., Louvain, Belg.); Meulders, J.-P. Phys. Rev., C; 1: 1326-32 (Apr 1970).

Total elastic and inelastic scattering cross sections for fast neutrons are measured on ^{12}C between 17 and 20.5 MeV in order to check the validity of standard optical-model parameters and to investigate the nature or resonant states in ^{13}C. The region around 18 MeV is found to be free of isolated resonances, and good fits are obtained with standard parameters. A resonant state is apparent at an energy corresponding to 23 MeV in ^{13}C, and indications of the spin and the structure of this state are obtained. (auth)

49767 PION PRODUCTION IN PION–NUCLEUS COLLISIONS. Eisenberg, J. M. (Univ. of Virginia, Charlottesville. Tel-Aviv Univ., Israel). Nucl. Phys.; A148: 135-44(1970).

Theoretical aspects of the $(\pi, 2\pi)$ reaction in complex nuclei were studied using soft-pion techniques. A number of advantages offered by this process for the study of $J^\pi = 0^-$ spin–isospin oscillations in closed shell nuclei are discussed. Numerical applications of the theory are made for ^{4}He and ^{16}O. The corresponding cross sections are expected to be quite small, but should be accessible as accelerators become available which produce mesons more copiously. (auth)

49768 CORRELATION EFFECT ON UNIQUE FORBIDDEN DECAYS. Bertsch, G. (Massachusetts Inst. of Tech., Cambridge); Molinari, A. Contract AT(30-1)-2098. Nucl. Phys.; A148: 87-96(1970).

The hindrance in some unique first-forbidden beta decays is related to the repulsive T = 1 particle-hole force. Calculations are performed for ^{17}N, ^{39}Ar, and ^{41}K. The qualitative trend agrees with experiment, but not the numerical results. (auth)

49769 HADRON-NUCLEUS FORWARD DISPERSION RELATIONS. Ericson, T. E. O.; Locher, M. P. (CERN, Geneva). Nucl. Phys.; A148: 1-61(1970).

Forward elastic scattering of pions and nucleons from complex nuclei was investigated by dispersion relations (FDR). Explicit applications cover πD, $\pi^{4}He$, $\pi^{9}Be$, $\pi^{12}C$, $n^{4}He$, and $n^{12}C$. Partly unpublished numerical evaluations are given. Results are expected to be typical for a wide range of nuclei. The unphysical region for π-scattering on I = 0 nuclei is unimportant. For the I = ½ nucleus ^{9}Be, an effective π-nuclear coupling constant $(f^2)_{eff} \approx 0.06$ is determined. With simple assumptions, general sum rules are shown to give universally $(f^2)_{eff} = f^2_{nucleon}$ as well as small unphysical contributions to the isospin-independent amplitude. Important exchange contributions from exchange diagrams (poles and cuts) are shown to appear in nucleon scattering at lower energies. This is shown to be consistent with single-particle potential scattering (optical model). The phenomenological potential scattering background term in slow neutron scattering is largely due to such exchange contributions. Antiparticle cross sections are shown to give small effects in low-energy nucleon scattering. A nonrelativistic approximation to the relativistic FDR is compared to FDR for potential scattering and the Born term is empirically determined for $n^{4}He$. Good agreement is obtained by comparison with the empirical potential for differential $n^{4}He$ scattering at low energy. A self-contained elementary discussion and review of FDR is given. The relation between asymptotic wave functions and pole residues is discussed in detail. Particular attention is drawn to the importance of an exponential dependence of residues on binding and radius, and it is illustrated by simple models. (auth)

49770 STUDY OF THE $^{12}C(\alpha,2\alpha)$ REACTION BY 100-MeV α PARTICLES. Jacquot, C.; Sakamoto, Y.; Jung, M.; Baixeras-Aiguabella, C.; Girardin, L.; Braun, H. (Laboratoire de Physique Corpusculaire, Strasbourg). Nucl. Phys.; A148: 325-36(1970). (In French).

The reaction $^{12}C(\alpha,2\alpha)^{8}Be$ was observed by using 90-MeV alpha particles in ionographic matter. The excitation energy spectrum of the residual nucleus ^{8}Be clearly showed the 0^+, 2^+, 4^+ states. The spectrum calculated with the cluster-model wave function for ^{12}C was compared with the observed data. The energy spectrum of the energetic outgoing α particle was calculated and compared with the data. The $(\alpha,2\alpha)$ reaction is most likely to occur in the outer region of the nucleus. (auth)

49771 STUDY OF (n,d) AND (n,t) REACTIONS ON ^{7}Li. Miljanic, D.; Furic, M.; Valkovic, V. (Inst. Rudjer Boskovic, Zagreb). Nucl. Phys.; A148: 312-24(1970).

Charged-particle spectra from neutron irradiation of ^{7}Li were measured at several angles. The angular distribution of deuterons from the $^{7}Li(n,d)^{6}He(g.s.)$ transition was compared with the DWBA prediction. The absolute value of the cross section was in satisfactory agreement, but the shape of the measured angular distribution was not well reproduced by the calculations. The angular distribution of tritons in the peak of the spectra was compared with the DWBA prediction for the pickup of two nucleons. The shape of the angular distribution was reproduced reasonably well. A discrepancy in the absolute value was interpreted as a consequence of quasi-free n-t scattering. (auth)

49772 POLARIZATION OF PROTONS ELASTICALLY SCATTERED FROM BERYLLIUM. Loyd, D. H.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys.; A148: 236-48 (1970).

The polarization in proton elastic scattering from ^{9}Be was measured using the polarized beam from a tandem accelerator. Angular distributions of the polarization were measured at twelve energies between 3.0 and 12.0 MeV. An optical-model analysis was performed of the present polarization measurements and previously measured cross sections. The optical model was found to reproduce the data quantitatively only for incident proton energies above 9 MeV. (auth)

49773 RADIATIVE PION ABSORPTION IN NUCLEI AND SOFT-PION THEOREMS. Fulcher, L. P. (Univ. of Virginia, Charlottesville. Univ., Frankfurt am Main); Eisenberg, J. M. Nucl. Phys.; B18: 271-300(1970).

The analogy between radiative pion absorption and muon capture is contained in a soft-pion theorem which states that the matrix elements of radiative pion absorption are those of the axial-vector current involved in muon capture. This soft-pion theorem is derived, and two methods of calculating radiative absorption rates, for pions bound in the 1S atomic orbital, from the corresponding muon capture rates are presented. The first method treats the nucleus as an elementary particle and uses electron scattering data in order to account for the vector part of the muon capture process; the second method uses nuclear photoexcitation information in order to account for the vector part of this process. Corrections to the soft-pion theorem are considered. In particular, the nuclear Fermi gas model is employed in order to estimate the corrections due to absorption of the pion and due to the nuclear Fermi motion. These corrections are found to be small. Further, corrections due to the rescattering of the pion are considered. They reduce the radiative pion absorption rate by approximately 60% in ^{12}C. (auth)

49774 PHOTONEUTRON EMISSION FROM Li, Be, V, Mn, Co, Ni, Pb, AND Bi. Garfagnini, Raffaello; Piragino, Guido; Zanini, Alba (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 47: 33-8(Jul-Aug 1969).

The energy distribution at 135° for photoneutrons, produced by

an 85-MeV bremsstrahlung beam, was measured for the nuclei ^{7}Li, ^{9}Be, ^{51}V, ^{55}Mn, ^{59}Co, Ni, Pb, and ^{209}Bi. Data for ^{7}Li and ^{9}Be were also taken at 90°. Results are shown for neutron energies between 0.8 and 12 MeV. At low neutron energy, the high-Z yield is greater than that for low Z; at high energy, the reverse is true. (R.W.R.)

49775 STUDY OF THE REACTIONS (p,^{6}Li) AND (p,^{6}He) ON ^{9}Be AT 45 MeV. Devries, R. M.; Paic, G.; Perrenoud, J. L.; Singh, M.; Sunier, J. W. (Univ. of California, Los Angeles). Phys. Lett.; 32B: 193-4(22 Jun 1970).

Angular distributions of the reactions (p, ^{6}Li) and (p, ^{6}He) on ^{9}Be at 45 MeV were measured. By comparing them conjectures are made about the reaction mechanisms and the p-^{6}He interaction. (auth)

49776 LIFETIME OF ^{18}Ne AND THE SECOND CLASS CURRENT PROBLEM. Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.); Wilkinson, D. H. Phys. Lett.; 32B: 190-2(22 Jun 1970).

The half-life of ^{18}Ne is found to be 1.67 ± 0.02 sec. The ft-value for the ^{18}Ne transition to the ground state of ^{18}F divided by that for the mirror transition between ^{18}O and ^{18}F is 0.992 ± 0.015. This removes a disturbing anomaly in a survey of ft-values for mirror beta-decay directed towards testing for the possible existence of second class currents. (auth)

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49777 (COO-1746-39) RESEARCH IN NUCLEAR PHYSICS. Progress Report No. 3, June 1, 1969–May 31, 1970. Steffen, R. M. (Purdue Univ., Lafayette, Ind. Nuclear Structure Lab.). 15 Jun 1970. Contract AT(11-1)-1746. 89p. Dep. CFSTI.

CADMIUM-110—energy-level transitions in, E2/M1 multipole mixing ratios in, (E)
COBALT-58—electron capture decay of directional correlation of iron-58 gamma rays from, (E)
COINCIDENCE CIRCUITS—development for ultra-short lifetime measurements
DYSPROSIUM-160—energy-level transitions in, quadrupole/dipole mixing ratios of, (E)
ERBIUM-168—excitation by proton scattering, (E)
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IRON-58—energy-level transitions from cobalt-58 electron-capture decay, directional correlation of gamma radiation from, (E)
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OSMIUM-186—energy-level transitions in, E2/M1 multipole mixing ratios in, (E)
OSMIUM-188—energy-level transitions in, E2/M1 multipole mixing ratios in, (E)
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THULIUM-169—magnetic interaction of implanted ionic, in ferromagnetic materials, (E/T)
VAN DE GRAAFF ACCELERATORS—development and operation of Purdue FN tandem, June 1, 1969–May 31, 1970
VAN DE GRAAFF ACCELERATORS—experimental facilities for Purdue FN tandem, description of (M.C.G.)

49778 (CTC-20) THE USE AND "TESTING" OF Al, Fe, Ni, Cu, AND Pb SECONDARY GAMMA-RAY PRODUCTION DATA SETS FROM THE POPOP4 LIBRARY. Ford III, W. E.; Wallace, D. H. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 1 Jul 1970. Contract W-7405-eng-26. 169p. Dep. CFSTI.

Aluminum, iron, nickel, copper, and lead secondary gamma-ray yield data sets for gamma-rays resulting from neutron capture and inelastic scattering reactions were evaluated by comparing calculated secondary gamma-ray pulse height spectra with spectra measured at the Tower Shielding Facility. The calculated spectra were obtained by using a discrete ordinates transport code to calculate the secondary gamma-ray angular flux resulting from the exposure of slabs of the materials of interest to bare, cadmium-filtered, boron-filtered, and "thermal" neutron beams from the TSR-II reactor and then folding the angular flux into pulse height spectra. The FORTRAN-IV codes LINFOLD, A Sample Simple Coupling Code, and POPOP4 Library Tape Maker are described. LINFOLD folds the calculated intensity of photons striking a NaI(Tl) detector into secondary gamma-ray pulse height spectra and compares calculated and measured spectra. A Sample Simple Coupling Code couples P_N neutron cross section sets, P_N gamma-ray cross section sets, and POPOP4 P_0 secondary gamma-ray production cross sections into P_N coupled cross sections for use with ANISN, DOT, MORSE, etc., transport codes. POPOP4 Library Tape Maker makes or updates a binary library tape of yield data sets for use with POPOP4. The latter code also makes or updates a BCD formatted library tape of yield data sets. (auth)

49779 (EURFNR-741) MEASUREMENT AND CALCULATION OF STRENGTH FUNCTION VALUES FOR NUCLEI IN THE 3s-RESONANCE RANGE. Mueller, K.-N.; Rohr, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Translation of report KFK-1114. 83p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 30723.

49780 (EURFNR-808) TOTAL CROSS SECTIONS OF ^{45}Sc, ^{47}Ti, ^{49}Ti, ^{52}Cr, AND ^{61}Ni IN THE keV REGION. Cho, M.; Froehner, F. H.; Kazerouni, M.; Mueller, K.-N.; Rohr, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Jun 1970. 16p. (KFK-1230; CN-26/11-s; CONF-700605-6). Dep. CFSTI (U. S. Sales Only).

Work Performed under United States–Euratom Fast Reactor Exchange Program.

From 2nd International Conference on Nuclear Data for Reactors, Helsinki, Finland.

Neutron total cross sections of separated isotopes were measured with a time-of-flight spectrometer using a 3-MeV Van de Graaff accelerator as neutron source. The neutron energy ranged from 10 to 250 keV. The energy resolution was between 0.2 and 0.5 nsec/m. The cross sections were shape analyzed in terms of an R-matrix multilevel formula. Thus, neutron widths and spins for up to 50 resonances per isotope could be determined. Average neutron widths, level densities, and strength functions were derived. The spin dependence of strength functions and the distribution of widths and spacings were investigated. (auth)

49781 (IS-T-363) THE RADIOACTIVE DECAY OF ^{190}Re AND ISOMER RATIO MEASUREMENTS IN PHOTONUCLEAR REACTIONS. Haustein, Peter Eugene (Ames Lab., Iowa). 1970. Contract W-7405-eng-82. 113p. Dep. CFSTI.

Thesis.

The decay of the ground state of ^{190}Re(3.1min) was investigated using Ge(Li) and scintillation detectors. Sources were prepared by the reaction ^{192}Os(γ,np)^{190}Re. Seventeen gamma transitions following the ~100% beta branch to the 1387-keV level of ^{190}Os were observed and placed into a decay scheme based on the known levels of ^{190}Os. A previously unreported 432-keV transition depopulating the 1387-keV level was observed. Beta measurements yielded an end-point energy of 1.8 ± 0.2 MeV for ^{190}Re. Log ft calculations indicated that ^{190}Re has a spin between 2 and 4 and negative parity. Experiments on electron capture decay of ^{190}Ir(12 day) into the ^{190}Os levels confirmed these results. The previously reported 2.8 hr ^{190}Re isomer was not observed. Isomer ratio measurements for the reactions $^{A+2}$Z(γ,3n)^{A}Z and $^{A+1}$Z(γ,n)^{A}Z (^{A}Z = ^{91}Mo, ^{113}In, ^{137}Ce, and ^{141}Nd) were made using isotopically separated targets and 70-MeV bremsstrahlung. More uniform population of the ^{A}Z isomeric pair states was observed by the (γ,3n)

reaction mode versus the (γ,n) mode. This behavior is discussed in terms of the photoabsorption process and the neutron emission modes of the compound nucleus. (auth)

49782 (IS-T-364) THE RADIOACTIVE DECAY OF ^{165}Ho AND ^{169}Ho. Haustein, Peter Eugene (Ames Lab., Iowa). 1970. Contract W-7405-eng-82. 37p. Dep. CFSTI.

Thesis.

Gamma rays accompanying the β^- decay of ^{169}Ho(3.3 min) and ^{165}Ho(4.8 min) were investigated using Ge(Li) detectors. Sources were prepared by the reactions ^{170}Er$(\gamma,np)^{169}$Ho and ^{170}Er$(\gamma,p)^{169}$Ho from targets of isotopically enriched $^{170}Er_2O_3$ (>96%) and from erbium metal of natural isotopic distribution. Eight gamma transitions were observed in the ^{169}Ho decay and 21 transitions in the ^{165}Ho decay. Several additional weak, short lived gamma rays (>1 MeV) were observed that could not be definitely assigned to either activity due to their similar half-lives. Energies and relative intensities are reported for these transitions. Gamma decay schemes are proposed for these two activities based on previously deduced energy level structure in ^{165}Er and ^{169}Er. The decay of ^{165}Ho occurs primarily to the 2^+ and 3^+ members of the K = 2, γ-vibrational band of ^{165}Er. The spin of odd–odd ^{165}Ho was deduced to be 3^+ by the method of Gallagher and Moskowski. The decay of the ^{169}Ho ground state assigned to the $\frac{1}{2}^-$(523) Nilsson state occurs primarily to the first two members of the $\frac{1}{2}^-$(523) rotational band in ^{169}Er. The γ decay pattern of the $\frac{1}{2}^-$(523) rotational states to lower lying bands ($\frac{1}{2}^-$(521), $\frac{3}{2}^-$(512), and $\frac{1}{2}^+$(633)) is discussed. This decay pattern is shown to be consistent with the Nilsson model predictions for nuclei in this mass range. (auth)

49783 (IS-T-365) DECAY OF ^{73m,g}Se, ^{73m}Ge, AND ^{77m,g}Ge. Meeker, Ralph Dennis (Ames Lab., Iowa). May 1970. Contract W-7405-eng-82. 97p. Dep. CFSTI.

Thesis

The decay of ^{73m,g}Se, ^{73m}Ge, and ^{77m,g}Ge were investigated using Ge(Li) gamma singles measurements, Ge(Li)–Ge(Li) and NaI(Tl)–Ge(Li) coincidence measurements, and delayed coincidence measurements. A decay scheme for ^{73m,g}Se was constructed using high-resolution gamma singles measurements and Ge(Li)–Ge(Li) and NaI(Tl)–Ge(Li) coincidence measurements. Branching ratios and log(ft) values for decay to the levels of ^{73}As were calculated. Experiments on the decay of ^{73m}Ge give a value of 139.8 ± 0.1 keV for the isomeric transition and set upper limits on the direct beta decay of this $\frac{5}{2}^+$ isomer to low-lying positive parity levels in ^{73}As. The lifetime of the 632 keV $\frac{5}{2}^+$ level in ^{77}As was measured to be 75 ± 15 psec using gamma rays emitted following the decay of ^{77}Ge. Two low-spin negative parity levels were located in the ^{77}As level scheme using gamma rays following the decay of ^{77m}Ge, including a first excited state at 195 keV with $I^\pi = \frac{1}{2}^-$. The experimental data for the levels of ^{73,75,77}As were compared with the predictions of the Coriolis coupling model. (auth)

49784 (KFK-1171) MEASUREMENT OF THE EXCITATION FUNCTION OF THE (d,x) REACTION ON ^{59}Co. Bilabel, R. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Apr 1970. 15p. (In German). Dep. CFSTI (U. S. Sales Only).

Excitation functions for the production of ^{57}Ni, ^{60}Co, ^{56}Co, ^{57}Co, ^{58}Co, ^{59}Fe, ^{56}Mn, ^{54}Mn, and ^{51}Cr by irradiation of ^{59}Co with deuterons were measured, with single foils and a stacked-foil arrangement, in the energy range from 10 to 52 MeV. The beam current of the incident deuterons of the Karlsruhe Isochronous Cyclotron was determined with aluminum monitor foils using the ^{27}Al(d,pα)^{24}Na reaction. The error in the absolute cross section scale was estimated as 15%. (auth)

49785 (SINP-TH-67-20) VALIDITY OF HARTREE–FOCK CALCULATIONS BEFORE ANGULAR MOMENTUM PROJECTOR: A TEST IN ^{20}Ne. Satpathy, L.; Nair, S. C. K. (Saha Inst. of Nuclear Physics, Calcutta (India)). [1967]. 8p. Dep. CFSTI (U. S. Sales Only).

A variational calculation after angular momentum projections for the first three even-parity states of ^{20}Ne (J = 0, 2, and 4) is performed. A comparison of these results with those of a Hartree–Fock calculation before angular momentum projection provides a justification for the latter procedure. (auth)

49786 (TID-25477) NUCLEAR STRUCTURE OF ^{110}Pd AND ^{116}Cd VIA THE (p,p′) AND (p,p′γ) DIRECT REACTIONS. Deye, James Alan (Vanderbilt Univ., Nashville, Tenn.). Aug 1970. 174p. Dep. CFSTI.

Thesis.

An investigation was made of the degree to which ^{110}Pd and ^{116}Cd exhibit phonon character. Inelastic proton scattering and proton–gamma coincidence experiments were carried out. The collective-vibrational nuclear model and the direct-interaction model are discussed in relation to this work. The cross sections for excitation of the states in the two-phonon region were compared to the predictions of the direct-interaction coupled-channel theory. Quite acceptable fits to the experimental cross sections were achieved by assuming some one-phonon admixture in these predominantly two-phonon states. (M.C.G.)

49787 INVESTIGATION OF ^{22}Na EXCITED STATES. Anttila, A.; Bister, M.; Arminen, E. (Univ. of Helsinki). Z. Phys.; 234: 455–64(1970).

Fourteen ^{21}Ne(p,γ)^{22}Na resonances were observed in the range E_p = 300 to 1,300 keV. The γ-decay of all these resonances was investigated by means of a 38 cm^3 Ge(Li) detector. Energies and branching ratios of several bound states were determined. The Q-value was determined as 6,738.5 ± 1.7 keV. Lifetimes of seven states were determined with the Doppler-shift attenuation method. The observed upper limit ($\tau_m \lesssim 4$ fs) of the lifetime for the 4,071-keV state, regarded as the analog of the third excited state in ^{22}Ne, and the transition observed from this state to the 1,528 keV state do not support the proposed rotational band structure of the ^{22}Na low-lying states. (auth)

49788 NUCLEAR PHOTO-EXCITATION OF T = $\frac{3}{2}$ STATES IN ^{23}Na AND ^{31}P. Shikazono, N.; Kawarasaki, Y. (Japan Atomic Energy Research Inst., Tokai). Phys. Lett.; 32B: 473–5(17 Aug 1970).

A measurement of γ-ray resonant scattering has been made. The lowest T = $\frac{3}{2}$ state in ^{23}Na was found to be strongly excited; the ground-state width has been estimated as 1.0 ± 0.4 eV. In contrast, the lowest T = $\frac{3}{2}$ state was not observed in ^{31}P; the ground-state width has been estimated to be smaller than 0.11 eV. These M1 transition strengths were compared with the ft values of analogous Gamow–Teller β decays. (auth)

49789 SPECTROSCOPIC FACTORS FOR l_n = 1 AND l_n = 3 TRANSITIONS IN (d,p) REACTIONS WITH SOME CALCIUM AND CHROMIUM NUCLEI. Brown, G.; Denning, A.; MacGregor, A. E. (Bradford Univ., Eng.). Nucl. Phys.; A153: 145–71(1970).

Measurements were made of the absolute differential cross sections for elastic deuteron scattering and (d,p) reactions with isotopes of calcium and chromium at incident energies of 10 MeV and for some Ca isotopes at 12 MeV. Deuteron-nucleus optical-model parameters are derived. It is shown that zero-range local DWBA calculations without spin-orbit potentials can be used to extract satisfactory spectroscopic factors for $1f_{\frac{7}{2}}$ and 2p transitions in the 1f-2p shell. (auth)

49790 STUDIES AIMED AT THE CLARIFICATION OF THE LAWS GOVERNING THE RADIOACTIVE DECAY PROCESSES. Berenyi, Denes (Nuclear Research Inst., Debrecen, Hungary). Magy. Fiz. Foly.; 18: 23–76(1970). (In Hungarian).

The as yet unanswered questions of electron capture, internal conversion and internal bremsstrahlung were subjected to a detailed study, considering specifically the following problems: branching of electron capture and positron emission in the ^{56}Co (ground state, 4^+) – ^{56}Fe(2085 keV, 4^+) transition; ratio of internal conversion coefficients in the higher shells in the 364 keV transition of ^{131}I; spectrum of the internal bremsstrahlung accompanying the electron capture of ^{36}Cl; spectrum of the integral bremsstrahlung in the β decay of ^{32}P. The differential measurements of the energy distribution of the internal bremsstrahlung accompanying β decays included an examination of this process in the 11-minute, positive β decay of ^{11}C and the internal bremsstrahlung spectrum of ^{204}Tl, taking into account the required corrections for the Compton distribution in the scintillation spectrum, the photopeak efficiency, γ and β absorptions and coincidence efficiency. The experimental system was checked by measuring the known internal bremsstrahlung of ^{32}P. (Doctoral Dissertation) (TTT)

49791 ANALOG RESONANCES IN ^{49}V AND ^{51}V. Maripuu, S. (State Univ., Utrecht). Nucl. Phys.; A153: 183–92(1970).

The E_p = 1007, 1013 and 1362 keV resonances in the ^{48}Ti(p,p)^{48}Ti and ^{48}Ti(p,γ)^{49}V reactions were studied. The J^π values have been determined as $\frac{1}{2}^-$, $\frac{3}{2}^-$ and $\frac{1}{2}^-$, respectively. The first two resonances are believed to form the split analog of the E_x = 1384 keV state in ^{49}Ti. The third is probably the analog of the E_x = 1724 keV state. In the ^{50}Ti(p,p)^{50}Ti and ^{50}Ti(p,γ)^{51}V reactions the E_p = 1366, 1371 and 1377 keV resonances were investigated. The J^π values are determined as $\frac{3}{2}^-$ for all three resonances. These resonances form the split analog of the ^{51}Ti ground state. The strengths and γ-ray branching ratios of all above mentioned resonances were studied. Excitation energies of some low-lying levels are also given. The results are compared with those of other similar investigations and with theoretical predictions. (auth)

49792 RECOIL STUDIES OF THE INTERACTION OF ^{48}Ca WITH 18 TO 36-MeV ^{4}He IONS AND 5 TO 43-MeV ^{3}He IONS. Gordon, B. M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys.; A153: 225-32(1970).

Thin-target thick-catcher recoil experiments are described for the $(\alpha,\alpha n)$, $(^3He,\alpha)$ and $(^3He, p2n)$ reactions on neutron-excess ^{48}Ca with 18 to 36 MeV ^{4}He ions and 5 to 43 ^{3}He ions. Product distributions between the target and catcher foils are compared with Monte Carlo calculations assuming compound nucleus and direct interaction mechanisms. Using these comparisons the $(\alpha,\alpha n)$ and $(^3He,\alpha)$ excitation functions are broken down into their direct interaction and compound nucleus components. The direct interaction contribution to the $(\alpha,\alpha n)$ reaction at 36 MeV is in the range of 20% to 40%. It is found that the thin-target experiments probably afford better differentiation between direct interaction and compound nucleus mechanisms than the comparable thick-target experiments. (auth)

49793 FURTHER EVIDENCE OF A $K^\pi = 3/2^+$ BAND IN THE MIRROR NUCLEI ^{25}Al AND ^{25}Mg. Roepke, H.; Brundiers, H. J.; Hammel, G. (Univ., Freiburg i.B.). Nucl. Phys.; A153: 211-24(1970).

A new level in ^{25}Al at $E_x = 6328 \pm 3$ keV was located as a resonance in the ^{24}Mg(p,p'γ) reaction at $E_p = 4227 \pm 2$ keV. From proton and γ-ray angular distributions $J = 3/2$ is assigned to the resonance. Very low limits ($\theta_l^2 \approx 10^{-4}$) on the proton reduced widths are imposed by the intensities of the resonant elastic and inelastic scattering. The reduced widths are similar to those of the known $E_p = 2.007$ MeV, $J^\pi = 3/2^+$ and the $E_p = 2.408$ MeV, $J^\pi = 5/2^+$ resonances. The three levels are suggested to be the lowest members of a $K^\pi = 3/2^+$ band. The corresponding $J^\pi = 3/2^+$, $5/2^+$ levels in the mirror nucleus ^{25}Mg were investigated with the ^{23}Na(^{3}He,p) reaction. A L = 0 two-particle transfer was observed to the $J^\pi = 3/2^+$ level. The relevance of this result is discussed. (auth)

49794 STUDY OF ^{132}Xe EXCITED STATES. Ardisson, Gerard (Alger Univ., Algeria); Marsol, Claire. Compt. Rend., Ser. B; 270: 913-15(6 Apr 1970). (In French).

A level scheme of ^{132}Xe obtained through ^{132}I β^- decay is proposed. Seven new energy levels are given: 2755.7; 2855.3; 2958.5; 3112.1; 3154.1; 3238.2 and 3270.8 keV. The following levels, previously observed, are confirmed: 2891.1; 2917.6; 3076.7; 3193.3; 3322.9; 3385.6 keV, while the 2447; 2656; 3283 and 3306 keV levels could not be observed. (France)

49795 NEW ISOTOPES ^{158}Tm AND ^{160}Tm. de Boer, F. W. N.; Goudsmit, P. F. A.; Koldewijn, P.; Meijer, B. J. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta; 13: 118-19(1970).

Samples of erbium oxide were irradiated in the proton beam of the Institute Synchrocyclotron for periods of ~30 sec. The gamma spectra were measured in counting periods of 60 sec each were started about 3 min after the end of the irradiations. Activities attributed to ^{160}Tm and ^{158}Tm were identified. Energy and intensity values for the gamma transitions assigned to the decay of these isotopes are listed along with the half-life for each line. (M.C.G.)

49796 NUCLEAR REACTIONS INDUCED BY HEAVY IONS. Proceedings of the International Conference, Heidelberg, 15-18 July 1969. Bock, R.; Hering, W. R. (eds.). New York; American Elsevier Publishing Company, Inc. (1970). 835p. (CONF-690707).

One hundred and three papers presented at the conference are included. Separate abstracts were prepared for 99 of the papers. The remaining four papers were previously abstracted for NSA. For abstract numbers of these papers see CONF-690707 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 48072, 48124, 48125, 48284, 49043, 49646-49658, 49720-49759, 49797-49825, 49880-49889, 49941, and 49942.

49797 STATISTICAL SIGNIFICANCE OF PARAMETERS DESCRIBING ^{40}Ca(α,α_0)^{40}Ca SCATTERING. Eberhard, K. A.; Bisson, A. E.; Davis, R. H. (Florida State Univ., Tallahassee). pp 89-92 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Statistical model quantities were compared with theoretical predictions and with experimental results obtained from analyzing the excitation functions in terms of the statistical fluctuation theory. The energy dependence of σ and ρ parameters was studied. (M.C.G.)

49798 ^{40}Ca(^{16}O,^{12}C)^{44}Ti REACTION AND THE STATES IN ^{44}Ti. Friedman, A. M.; Fortune, H. T.; Morrison, G. C.; Siemssen (Argonne National Lab., Ill.). pp 171-3 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The (^{16}O,^{12}C) reaction on calcium-40 to several previously unreported levels in ^{44}Ti is reported. Angular distributions and energy levels are given. (M.C.G.)

49799 EVIDENCE FOR TWO MECHANISMS IN SINGLE TRANSFER REACTIONS ON HEAVY TARGETS. LeFort, M.; Basile, R.; Galin, J.; Guerreau, D.; Peter, J.; Tarrago, X. (Laboratoire Chimie Nucleaire, Orsay, France). pp 181-4 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Results on silver targets with 86-MeV ^{12}C ions and 112-MeV ^{14}N ions are presented. The cross sections for transfer reactions are given along with angular and energy distributions. It was concluded that the projectile sticks to the target for a very short time during the exchange of nucleons, although the trajectory was strongly deviated in the forward direction by nuclear forces. (M.C.G.)

49800 NEUTRON AND PROTON TUNNELLING REACTIONS WITH ^{208}Pb. Phillips, W. R. (Univ. of Manchester, Eng.); Barnett, A. R. pp 187-90 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Nucleon tunnelling cross sections for ^{16}O ions on ^{208}Pb are presented. The bombarding energy was 69.1 MeV and products were observed over the angular range 100 to 170°. The total cross section for the neutron tunnellings involving all the levels is 2.2 ± 0.1 mb. (M.C.G.)

49801 TRANSFER REACTIONS BETWEEN HEAVY IONS IN THE SUBCOULOMB ENERGY REGION. Trautmann, D.; Adler, K. (Univ. of Basel). pp 191-6 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

For small energies where penetration is negligible, the matrix elements describing the transfer reaction are very similar to those occurring in the theory of Coulomb excitation. Equations are given for describing the bound neutron radial wave function in the final state. For computation of matrix elements, a partial wave decomposition for the incoming and outgoing waves is used. A semi-classical expression for the differential cross section is given. (M.C.G.)

49802 COULOMB STRIPPING IN HEAVY IONS REACTIONS VIA TARGET EXCITATION. Nakamura, Kosuke (Univ. Libre, Brussels). pp 206-9 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A general formula is presented for the differential cross section for the Coulomb stripping of complex nuclei with the inclusion of the associated Coulomb excitation effect. (M.C.G.)

49803 MAGNETIC MOMENTS OF CORE EXCITED STATES OF ODD NUCLEI NEAR A = 100. Roney, W. M. (Univ. of Wisconsin, Madison); Kugel, H. W.; Heestand, G. M.; Borchers, R. R.; Kalish, Rafael. pp 419-23 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The magnetic moments of the $3/2^-$ and $5/2^-$ low lying doublet states of a number of odd-A nuclei in the mass region A = 70 to 130 were measured. Oxygen ions were used to excite levels in ^{77}Se, ^{103}Rh, ^{107}Ag, and ^{109}Ag. (M.C.G.)

49804 ENERGY-DEPENDENCE OF TRANSIENT FIELDS ON MOVING IONS IN FERROMAGNETIC SOLIDS. Hvelplund, P. (Univ. of Aarhus, Denmark); Herskind, B. pp 431-4 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Recoil ion implantation perturbed angular correlation experiments (IMPAC) were used to study Pt recoiled into Fe at different initial velocities. An oxygen beam of 26 and 36 MeV and a sulfur beam of 56 and 59 MeV were used to obtain initial recoil energies from 6 to 27 MeV. The target was made by sputtering ^{196}Pt onto a pure iron foil. The velocity dependence of the transient field acting on ions when stopped in ferromagnetic iron is shown to be well described by the Lindhard–Winther theory. (M.C.G.)

49805 TIME-DEPENDENT INTERACTIONS ON RARE-EARTH IONS IMPLANTED INTO COPPER LATTICES. Waddington, J. C. (Univ. of Copenhagen); Hagemann, K. A.; Ogaza, S.; Kiss, D.; Herskind, B.; Deutch, B. I. pp 438–41 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The integral angular correlations of the de-exciting gamma rays following Coulomb excitation were measured in copper for the first 2^+ states of ^{150}Nd, ^{150,152,154}Sm, ^{156}Gd, ^{160}Dy, ^{166}Er, and ^{174}Yb and from the first 4^+ states of ^{152}Sm, ^{160}Dy, and ^{166}Er in order to study ranges of elements and nuclear lifetimes. The temperature dependence of the magnetic interaction strength parameter was much more supportive of Blume's theoretical results over those of Abragam and Pound. (M.C.G.)

49806 COULOMB EXCITATION OF ^{154}Gd AND ^{166}Er. Riedinger, L. L.; Eichler, E.; Fuglsang, J.; Hagemann, G. B.; Herskind (Univ. of Copenhagen). pp 442–5 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A well-deformed nucleus, ^{166}Er, and a transition-region nucleus, ^{154}Gd, were studied by Coulomb excitation with 15-MeV α particles in order to obtain matrix elements directly connected to the ground state, and with 30 to 56 MeV ^{16}O to obtain matrix elements between the higher states. (M.C.G.)

49807 TIME DIFFERENTIAL PERTURBED GAMMA-RAY ANGULAR DISTRIBUTION OF HEAVY NUCLEI RECOILING INTO VACUUM. Brenn, R.; Spehl, H. (Univ., Freiburg i. B.). pp 446–9 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A time differential measurement confirmed the observations of Ben Zvi et al. [Nucl. Phys. A 121(1968) 592] of the perturbation of the angular correlation of gamma rays emitted from Coulomb excited nuclei recoiling into a vacuum. The conclusions were that the perturbation is due to a rapid and random fluctuation of the total angular momentum F of nucleus plus electron shell and that it arose mainly from magnetic dipole interaction. The initial polarization of the Yb or Er nuclei recoiling from a thin foil into vacuum was from the Coulomb excitation process with 16-MeV Ne^{3+} ions. (M.C.G.)

49808 INTERFERENCE BETWEEN COULOMB AND NUCLEAR EXCITATION. Pryor, R. J.; Saladin, J. X.; Bassel, R. H.; Drisko, R. M. (Univ. of Pittsburgh). pp 450–2 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The ratio $d\sigma_{tot}/d\sigma_{el}$ of α particles scattered by 135° in the energy range between 8 and 16 MeV on ^{114}Cd was measured. At 10 MeV there was a significant destructive interference between Coulomb and nuclear excitation. (M.C.G.)

49809 SEMI-CLASSICAL THEORY OF THE COULOMB AND NUCLEAR EXCITATION INTERFERENCE EFFECTS IN HEAVY ION SCATTERING. Leclercq-Willain, C. (Univ. Libre, Brussels). pp 453–6 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

In heavy ion scattering, the target nucleus was described in a phonon model and the residual interaction terms of the Coulomb and nuclear potentials defined by a development around the spherical equilibrium nucleus shape. The interference effects of the Coulomb and nuclear interactions on the "pure-Coulomb" results were more important for incident energies equal to or greater than the Coulomb barrier energy. (M.C.G.)

49810 REORIENTATION MEASUREMENTS IN ^{24}Mg AND ^{28}Si. Hasselser, O.; Alexander, T. K.; Pelte, D.; Hooton, B. W.; Evans, H. C. (Chalk River Nuclear Labs., Ont.). pp 457–60 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The static quadrupole moment of the first excited states in ^{24}Mg and ^{28}Si was determined by means of the reorientation effect in Coulomb excitation. The ^{24}Mg results were published previously [Phys. Rev. Letters 22(1969)359]. The quadrupole moment of ^{28}Si was measured by projectile excitation of a silicon beam on a ^{62}Ni target. Data are presented in graphs. A change in the sign of the static quadrupole moment of the first excited 2^+ states between ^{26}Mg and ^{28}Si was demonstrated. (M.C.G.)

49811 REORIENTATION EFFECTS IN THE ELECTRIC OCTUPOLE COULOMB EXCITATION OF ^{208}Pb. Barnett, A. R.; Phillips, W. R. (Univ. of Minnesota, Minneapolis). pp 461–3 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Measurements were made of the static quadrupole moment of the 3^- octupole state of ^{208}Pb. The reorientation effect was observed following Coulomb excitation of the state with both ^{4}He and ^{16}O ions. It was concluded that particle–hole calculations can reproduce the properties of the 3^- state. The value of the quadrupole moment was found to be −3.1 b. (M.C.G.)

49812 HEXADECAPOLE EFFECTS ON THE COULOMB EXCITATION OF NUCLEI IN THE RARE-EARTH REGION. Winkler, P. (Univ., Erlangen, Ger.). pp 464–6 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The multiple Coulomb excitation program by Winther and de Boer was extended to treat the electric hexadecapole interaction as exactly as the quadrupole excitation. Numerical results of the calculated 2^4-pole effects on the Coulomb excitation cross sections of the different energy levels of ^{152}Sm bombarded with ^{16}O ions are presented. (M.C.G.)

49813 PERTURBATION TREATMENT OF THE REORIENTATION EFFECT IN ^{165}Ho. Casas, E.; Winkler, P. (Univ., Erlangen, Ger.). pp 467–70 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Calculations on ^{165}Ho were of special interest for the $\frac{9}{2}^-$ state of the second γ-band, as for this state relatively few effects contribute in second order to the cross section in competition to the reorientation effect. The Faessler model was used in the calculations. In the first excited state ($\frac{9}{2}^-$) of the ground-state band the contribution of the reorientation was smaller and of opposite sign than the sum of all other second-order effects. In the $\frac{9}{2}^-$ state of the second γ-band the contribution of the reorientation was of the same order of magnitude but of opposite sign as the sum of all other second-order effects. (M.C.G.)

49814 DETERMINATION OF THE STATIC QUADRUPOLE MOMENT OF THE FIRST EXCITED 2^+ STATE OF ^{152}Sm AND ^{166}Er BY COULOMB EXCITATION WITH ^{16}O-IONS. Kaspar, G.; Knuepfer, W.; Ebert, W.; Holleczek, P.; Fichtiger, N. (Univ., Erlangen, Ger.). pp 471–4 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Experiments and careful evaluation of data were carried out to derive the quadrupole moment of the first excited 2^+ state of the deformed nuclei ^{152}Sm and ^{166}Er. Bombarding energies between 23 and 35 MeV were used and the backscattered ions were detected in an annular shaped solid state counter. Quadrupole moments were found to be (−1.65 ± 0.19) b for ^{152}Sm and (−2.87 ± 0.95) b for ^{166}Er. (M.C.G.)

49815 COULOMB EXCITATION OF MEDIUM-WEIGHT AND RARE EARTH NUCLEI WITH ^{16}O IONS. Robinson, R. L.; Stelson, P. H.; McGowan, F. K.; Sayer, R. O.; Milner, W. T. (Oak Ridge National Lab., Tenn.). pp 475–8 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Multiple Coulomb excitation effected with oxygen ions was used to study states of the medium-weight and rare earth nuclei not excited by direct E2 Coulomb excitation. Studies were made on ^{152}Sm, ^{166}Er, ^{172,174,176}Yb, and ^{107,109}Ag. (M.C.G.)

49816 QUANTAL SECOND ORDER PERTURBATION THEORY OF COULOMB EXCITATION. Pauli, H.; Morf, R.; Alder, K. (Univ. of Basel). pp 479-83 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The reorientation effect to second order perturbation theory was calculated. The reorientation coefficient is shown as a function of scattering angle. (M.C.G.)

49817 COULOMB DISTORTIONS IN HEAVY-ION REACTIONS. Holm, H.; Scheid, W. (Univ., Frankfurt am Main). pp 484-8 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A prediction is presented of the rising of the Coulomb barrier and of the excitation of internal degrees of freedom. It is shown that the adiabatic approximation used in the literature is only applicable for the description of the excitation of giant resonances but not suitable for rotations and vibrations. Vibrations and rotations do not have the time to acquire the position of minimal energy. Only the fast giant resonance oscillations can take up energy and give it back to the orbital motion almost adiabatically. (M.C.G.)

49818 THEORETICAL ASPECTS OF HEAVY-ION INDUCED COMPOUND REACTIONS. Boehning, M. (Technische Hochschule Munich). pp 633-56 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The formation of compound nuclei in heavy ion reactions is discussed. Features of these nuclei include: relatively high excitation energy, preferable excitation with high spin, and decay by evaporation or even fission. Separation of compound reactions, independence of formation and decay, the random phase hypothesis and the statistical reaction theory are considered. (38 references) (M.C.G.)

49819 COMPOUND NUCLEUS REACTIONS IN THE REGION OF THE HEAVY ELEMENTS. Gough, R. A.; MacFarlane, R. D. (Texas A and M Univ., College Station). pp 673-6 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The reactions ^{209}Bi + ^{12}C and ^{207}Pb + ^{14}N were studied over a range of bombarding energies from 65 to 120 MeV. Absolute cross sections were measured and 29 different reaction products were identified. Alpha spectra of the products are shown, along with excitation functions. (M.C.G.)

49820 SEARCH FOR ISOMERIC STATES IN THE REGION Z > 50, N < 82 PRODUCED BY (^{12}C,Xn) REACTIONS. Conlon, T. W.; Elwyn, A. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 677-80 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A search is being made for evidence of oblate nuclear states and for examples of shape-hindered gamma transitions produced following reactions of the type (^{12}C, Xn) on separated isotopes of Sn, Cd, and Sb. A pulsed beam of 88-MeV ^{12}C ions was used. Several short-lived isomes in the region Z > 50, N < 82 were observed. (M.C.G.)

49821 SOME NEW CAESIUM ISOMERS PRODUCED IN (H.I.,xn) REACTIONS. Chojnacki, S.; Droste, Ch.; Morek, T.; Wilhelmi, Z.; Alexander, K. F.; Neubert, W. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 681-3 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

For producing, identifying, and investigating the light Cs isotopes, an experimental arrangement on a cyclotron pulsed heavy-ion (H.I.) beam was used. By measuring the energies, intensities, and half-lives of the gamma rays and internal conversion electrons at various bombarding energies it was possible to: identify the (H.I., xn) reaction products and collect some spectroscopic information on the transition energies, multipolarities, and half-lives. (M.C.G.)

49822 NON-EQUILIBRIUM STATISTICAL MODEL FOR COMPOUND STATE DECAY. Blann, Marshall; Lanzafame, Frank M. (Univ. of Rochester, N. Y.). pp 687-9 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The decay of a compound state will be a function of the manner in which it is formed if the pre-equilibrium emission is a significant fraction of the total cross section. This question was explored for reactions induced with 20 to 80 MeV ^{4}He ions. It was concluded that a very considerable fraction of the reaction cross section may decay prior to attachment of statistical equilibrium. (M.C.G.)

49823 EVIDENCE FOR ANGULAR MOMENTUM FRACTIONATION IN COMPOUND NUCLEUS DECAY. Lyman, Warren J.; Blann, Marshall (Univ. of Rochester, N. Y.). pp 690-2 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

An attempt was made to provide direct experimental evidence for the fractionation mechanism in decay of compound nuclei. The systems selected for investigation were ^{58}Ni(α,αpn)^{56}Co and ^{58}Ni (α,αp2n)^{55}Co. The results were in agreement with the spin fractionation hypothesis for these reactions. (M.C.G.)

49824 STUDY OF HEAVY IONS EJECTED IN INTERACTIONS OF 19 GeV/c PROTONS ON Au TARGET, DEFLECTED BY MAGNETIC FIELD AND REGISTERED IN CELLULOSE NITRATE. Aiguabella, R.; Pfohl, R.; Schmitt, R. (Centre de Recherches Nucleaires, Strasbourg). pp 696-700 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Studies were made of "hammertracks" in cellulose nitrate coming from Au targets bombarded with a flux of 10^{14} p/cm^2. The tracks were measured in cellulose nitrate samples tilted at 21° against a plane perpendicular to the magnetic field. A search for ^{8}He was made. (M.C.G.)

49825 QUASI ROTATIONAL BANDS IN NEUTRON DEFICIENT BARIUM ISOTOPES. Albouy, G.; Lagrange, J. M.; Pautrat, M.; Poffe, N.; Sergolle, H.; Teillac, J.; Vanhorenbeeck, J. pp 706-11 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Experiments were carried out to observe the high spin levels evolution towards heavier isotopes and to extend the study to more deficient isotopes. The barium isotopes are produced by $^{116-124}$Sn (^{12}C, 4n)$^{124-132}$Ba and ^{115}In(^{14}N, 3n and 5n)$^{126 \text{ and } 124}$Ba reactions. The results for energies and relative yields for transitions attributed to the quasi-rotational bands are given. (M.C.G.)

49826 MEAN LIFETIME OF THE 2.94-MeV LEVEL IN ^{33}S. Ragan III, C. E. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Moss, C. E.; Gould, C. R.; Roberson, N. R.; Mitchell, G. E.; Tilley, D. R. Phys. Rev., C; 2: 557-60(Aug 1970).

The mean lifetime of the 2.94-MeV level in ^{33}S has been measured by the recoil distance method using the ^{30}Si(α,n)^{33}S reaction. The lifetime was found to be 40.5 ± 2.0 psec. (auth)

49827 LIFETIMES AND DECAY MODES OF ENERGY LEVELS IN ^{34}S. Greene, M. W.; Alderson, P. R.; Bailey, D. C.; Durell, J. L.; Green, L. L.; James, A. N.; Sharpey-Schafer, J. F. (Univ. of Liverpool). Nucl. Phys.; A148: 351-61(1970).

The excitation energies, branching ratios, and mean lifetimes of the low-lying levels in ^{34}S were measured. The lifetimes were measured by the Doppler shift attenuation method using the ^{31}P(α,p)^{34}S reaction at a bombarding energy of 7.0 MeV. The γ rays were detected at six angles with a Ge(Li)–NaI(Tl) anti-Compton and pair spectrometer. The mean lifetimes, in fs, were found to be: 2127 keV, 440 ± 50; 3303 keV,

218 ± 30; 3915 keV, 1600 ± 130; 4075 keV, <33; 4116 keV, 89 ± 20; 4623, 125 ± 20; 4688 keV, 132 ± 15; 4874 keV, <85; 4892 keV, <40; and 5318 keV, 24 ± 10. (auth)

49828 B(E2) FOR THE FIRST 2^+ STATE IN ^{60}Ni. Metzger, F. R. (Franklin Inst., Swarthmore, Pa.). Nucl. Phys.; A148: 362-8(1970).

A resonance fluorescence self-absorption experiment has been carried out for the 1.333-MeV first excited state in ^{60}Ni, using gaseous $^{60}CoCl_2$ as the source of the exciting gamma radiation. The B(E2↑) derived from this experiment, B(E2↑) = 938 ± 20 $e^2 \cdot fm^4$, is in good agreement with a recent Coulomb excitation result of comparable accuracy. The average of these two model independent measurements differs by more than four standard deviations from the B(E2) determined in an inelastic electron scattering experiment which had been analyzed using Tassies hydrodynamical model. (auth)

49829 ANGULAR DISTRIBUTIONS OF GAMMA RAYS FOLLOWING INELASTIC NEUTRON SCATTERING FROM ^{63}Cu AND ^{65}Cu. Felsteiner, J.; Serfaty, R. (Technion-Israel Inst. of Tech., Haifa). Nucl. Phys.; A148: 428-32 (1970).

Gamma-ray angular distributions from the $^{63,65}Cu(n,n'\gamma)$ reactions with 2.9-MeV neutrons were measured using a Ge(Li) detector. The data are found to be in good agreement with calculations based on the Hauser–Feshbach theory as corrected for width-fluctuation effects. There is, however, a large discrepancy between the present results and the γ-ray angular distribution measurements reported recently by Trunov et al. (auth)

49830 BETA–GAMMA DIRECTIONAL CORRELATIONS IN ^{56}Co, ^{141}Ce AND ^{110m}Ag. Wohn, F. K. (Iowa State Univ., Ames); Wilkinson, R. G. Nucl. Phys.; A148: 444-8(1970).

Beta–gamma directional correlations for the 485, 435, and 530 keV beta groups in ^{56}Co, ^{141}Ce, and ^{110m}Ag, respectively, were measured with a magnetic spectrometer and were found to be isotropic in each case. (auth)

49831 $^{86}Kr(d,p)^{87}Kr$ REACTION. Haravu, K.; Hollas, C. L.; Riley, P. J.; Coker, W. R. (Univ. of Texas, Austin). Phys. Rev., C; 1: 938-44(Mar 1970).

States of ^{87}Kr are investigated via the $^{86}Kr(d, p)^{87}Kr$ reaction with 11-MeV deuterons and an over-all energy resolution of 30 keV. Proton groups leading to 23 states in ^{87}Kr are identified. The angular-distribution data are analyzed using finite-range distorted-wave Born-approximation (DWBA) calculations to extract spectroscopic information. Spin and parity assignments, excitation energies, and spectroscopic factors for most of the observed levels are presented. Comparisons are made with preliminary data of proton elastic scattering from ^{86}Kr at isobaric analog resonances. (auth)

49832 MEASUREMENT OF THE INTERNAL PAIR FORMATION COEFFICIENTS IN ^{56}Co. Schneider, H.; Weng, U. (Univ., Giessen, Ger.). Z. Phys.; 235: 436-45(1970). (In German).

Internal pair formation probabilities in ^{60}Ni and ^{56}Co were determined by a positron annihilation method. The electrons from the β^--decay of ^{59}Fe were measured in triple coincidence with annihilation quanta originating from pairs produced in the deexcitation of the ^{56}Co nucleus. By this triple coincidence technique it was possible to measure separately the pair formation coefficients Γ for transitions in ^{56}Co. The observed values $\Gamma_{1.23} = (3.7 \pm 0.4) \times 10^{-5}$ and $\Gamma_{1.36} = (0.5 \pm 0.1) \times 10^{-5}$ are in agreement with theoretical calculations for E2-radiation. (auth)

49833 MAGNETIC MOMENTS AND M1 TRANSITIONS IN THE ODD-A COPPER ISOTOPES. Green, A. M.; Sundius, T. R. (Eidgenoessische Technische Hochschule, Zurich). Soc. Sci. Fenn., Comment. Phys.-Math.; 36: No. 4, 59-68(1969).

The magnetic moment operator is renormalized by including configurations in which a nucleon is excited from a $j = l + \frac{1}{2}$ orbit into a $j = l - \frac{1}{2}$ orbit. In ^{59,61,63,65,67}Cu this is found to be a great improvement over using simply the bare operators. (auth) (Finland)

49834 LEVELS IN ^{71}Ga EXCITED BY THE DECAY OF 4h ^{71}Zn. Taylor, H. W.; Singh, B. (Univ. of Toronto). Nucl. Phys.; A148: 548-60(1970).

A total of 37 γ-rays accompanying the β^- decay of 4h ^{71}Zn has been observed with a Ge(Li) spectrometer. Using coincidence techniques, a decay scheme has been prepared which incorporates 31 of the transitions into a level scheme for ^{71}Ga. Levels are proposed at the following energies: 389.6, 487.3, 511.4, 909.5, 964.6, 1107.3, (1396.4), 1475.8, 1493.8, (1707.1), 2247.1, 2429.5, 2450.6, 2487.5 and (2787.6) keV. The scheme is compared with the predictions of the vibrating core plus single-particle model. (auth)

49835 DIRECTIONAL CORRELATION MEASUREMENTS IN ^{86}Sr. Arns, R. G.; Martin, D. U.; Monahan, W. G.; Sprague, S. W. (Ohio State Univ., Columbus). Nucl. Phys.; A148: 625-31(1970).

Directional correlation measurements have been made on γ-rays of ^{86}Sr following the electron-capture and positron decay of ^{86}Y. The 1077 keV γ-ray (from the 2^+ first excited state) was detected in a NaI(Tl) crystal in coincidence with a 20 cm^3 Ge(Li) detector. Three cascade correlations (involving the 777 keV, 1153 keV and 1921 keV γ-rays) and two 1–3 correlations (intermediate radiation unobserved) are reported. The 777 keV transition (from the 2^+ state at 1854 keV) is found to be M1 + E2 with 7 ± 2% quadrupole content. The directional correlation results, together with additional experimental evidence, lead to assignments of 4^+, 3^-, 5^- and 3^- to the states of 2230 keV, 2482 keV, 2673 keV and 2997 keV, respectively. (auth)

49836 K-CONVERSION COEFFICIENTS OF TRANSITIONS IN ^{87}Sr. Kluk, A. F. (Vanderbilt Univ., Nashville); Krmpotic, D.; Hamilton, J. H.; Pinajian, J. J. Z. Phys.; 235: 391-4(1970).

The K conversion coefficients of the 388- and 483-keV transitions in ^{87}Sr populated in the decay of ^{87}Y were measured with Ge(Li) and Si(Li) detectors by the NPG method. Values of 0.162 ± 0.010 and 0.00260 ± 0.00013 were found for the 388- and 483-keV transitions, respectively. (auth)

49837 THE IDENTIFICATION OF MIRROR STATE STRUCTURE IN ^{21}Na AND ^{21}Ne. Lindgren, R. A.; Pronko, J. G.; Howard, A. J.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. Phys. Lett.; 32B: 103-6(8 Jun 1970).

Angular correlation studies with the $^{24}Mg(p,\alpha)^{21}Na(p_0)^{20}Ne$ reaction establish $J = \frac{5}{2}$ and $\frac{1}{2}$ spin assignments for the respective 3540 and 2804 keV ^{21}Na states. Mirror pair identification between the ^{21}Ne 2790 keV and ^{21}Na 2804 keV states indicates a $J^\pi = \frac{1}{2}^-$ assignment thereto. (auth)

49838 STUDY OF INTERNAL BREMSSTRAHLUNG FROM THE ELECTRON CAPTURE DECAY OF ^{54}Mn. Kadar, I.; Berenyi, D. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Phys.; A153: 383-9(1970).

The IB spectrum from the electron capture decay of ^{54}Mn was studied by coincidences between the IB quanta and the 835 keV γ-rays. The $(1.92 \pm 0.33) \times 10^{-4}$/K-capture experimental value found for the total intensity of IB agrees well with that of the Glauber-Martin theory. The end-point energy of the spectrum was found to be 633 ± 100 keV from the Jauch plot. Using this value, the total disintegration energy of the $^{54}Mn \rightarrow {}^{54}Cr$ decay was calculated to be 1474 ± 100 keV. (auth)

49839 CROSS-SECTIONS OF SOME (n,2n) REACTIONS INDUCED BY REACTOR FAST NEUTRONS. Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Radiochim. Acta; 13: 169-71(Jun 1970).

Cross sections for (n,2n) reactions induced in ^{23}Na, ^{55}Mn, ^{75}As, ^{89}Y, ^{127}I, and ^{185}Re by reactor fast neutrons were determined using the $^{58}Ni(n,p)^{58}Co$ reaction as a monitor. In addition, the reaction $^{54}Fe(n,p)^{54}Mn$ was studied. Good agreement between results obtained in different irradiations was obtained. (auth)

49840 INTERMEDIATE COUPLING MODEL FOR Br ISOTOPES. Stewart, K. W. C.; Castel, B. (Queen's Univ., Kingston, Ont.). J. Phys., A (London); 3: 390-9(Jul 1970).

The low-lying levels of ^{79}Br and ^{81}Br are studied in an intermediate coupling model. The main modification to the classical model consists in a microscopic description of the core, where the degeneracy of the second phonon vibrational triplet is removed. The calculated energy levels and transition rates compare well with recent results from Coulomb excitation experiments. (auth) (UK)

49841 REACTION CROSS SECTIONS OF $^{85}Rb(n,\gamma)^{86m}Rb$, $^{87}Rb(n,\gamma)^{88}Rb$, AND $^{89}Y(n,\gamma)^{90m}Y$ BETWEEN 0.16 MeV AND 1.5 MeV. Dudey, N. D.; Heinrich, Robert R.; Madson, Allen A. (Argonne National Lab., Ill.). J. Nucl. Energy; 24: 181-9(Jul 1970).

Fast neutron capture cross sections of $^{85}Rb(n,\gamma)^{86m}Rb$, $^{87}Rb(n,\gamma)^{88}Rb$, and $^{89}Y(n,\gamma)^{90m}Y$ were measured by the activation technique as a function of neutron energy between 160 keV and 1.5 MeV. These cross sections were measured relative to both the $^{235}U(n,f)$ and the $^{197}Au(n,\gamma)^{198}Au$ cross section. Neutrons were produced by the $^7Li(p,n)^7Be$ reaction from a Van de Graaff accelerator. The data of the $^{87}Rb(n,\gamma)^{88}Rb$ reaction were compared with calculations based upon the statistical compound nucleus model of nuclear reactions. For this case, the theory is able to fit the experimental data very accurately. (auth) (UK)

49842 DECAY OF ^{73}Ga. Ward, T. E.; Swindle, D. L.; Wright, R. J.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem.; 32: 2483-8(Aug 1970).

The decay of ^{73}Ga was studied with the use of a Ge(Li) spectrometer and β- and γ-ray scintillation detectors. A new γ-ray of 328 keV was found in coincidence with the previously known 740 keV γ-ray. The β branching of ^{73}Ga to the 0.53 sec isomeric state of ^{73}Ge was measured to have a 1.50 ± 0.10 MeV β end point with an intensity of 9 ± 1 per cent. A tentative decay scheme is presented. (auth) (UK)

49843 PROTON INDUCED RESONANCE REACTIONS ON ^{41}K. II. THE ^{41}K(p,p)^{41}K AND ^{41}K(p,n)^{41}Ca REACTIONS. de Meijer, R. J.; Risselada, T. F.; Berendsen, H. G. (Rijksuniversiteit, Utrecht). Nucl. Phys.; A148: 77-86(1970).

Analog states in ^{42}Ca were studied with the reactions ^{41}K(p,p)^{41}K and ^{41}K(p,n)^{41}Ca in the proton energy region E_p = 1.35–1.96 MeV. Partial widths were determined for a number of resonances. Possible analog states of seven levels in ^{42}K were identified. (auth)

49844 PROTON INDUCED RESONANCE REACTIONS ON ^{41}K. I. A HIGH-RESOLUTION INVESTIGATION OF THE ^{41}K(p,α_0)^{38}Ar REACTION. De Meijer, R. J.; Van Gasteren, J. J. M. (Rijksuniversiteit, Utrecht). Nucl. Phys.; A148: 62-76(1970).

In the energy region E_p = 1.17 to 2.10 MeV 213 resonances were observed from the reaction ^{41}K(p,α_0)^{38}Ar. Resonance and excitation energies, yields, and J^π values were determined, the latter from angular distribution measurements. The level density was compared with semi-empirical values. The appearance of $J^\pi = 1^-$ resonances, almost purely formed by channel spin s = 1, was explained with a Thomas–Porter distribution. Groups of resonances with the same J^π and nearly the same formation parameters might indicate split analog states. (auth)

49845 NORMALIZATION CONSTANT IN (^{3}He,α) REACTIONS. Lim, T. K. (Florida State Univ., Tallahassee). Nucl. Phys.; A148: 299-311(1970).

The normalization constant in DWBA theory of (^{3}He,α) pick-up reactions was evaluated in zero-range and local-energy approximations with the aid of realistic ^{3}He and α wave functions and a spin-dependent nucleon–nucleon interaction. The ^{3}He ground-state wave function includes a state of mixed symmetry, which has little effect on N(^{3}He,α), in sharp contrast to the results of recent (^{3}He,d) and (^{3}H,d) calculations. Evidence in support of the direct method of finding N and against Bassel's method of invoking the Schrödinger equations of the few-nucleon systems is cited. (auth)

49846 DECAY OF ^{54}V. Ward, T. E.; Pile, P. H.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-3235. Nucl. Phys.; A148: 225-35(1970).

The decay of ^{54}V was studied with the use of a Ge(Li) spectrometer and β and γ scintillation detectors. Eight new γ rays and 3 new β rays were observed and several coincidence measurements performed. A half-life of 43 ± 3 sec was measured and a β-decay Q-value of 7.0 ± 0.1 MeV was determined. A tentative decay scheme is presented and discussed in view of the more recent theoretical and experimental studies of ^{54}Cr. (auth)

49847 PROJECTED HARTREE–FOCK–BOGOLYUBOV CALCULATION FOR Ti ISOTOPES. Devi, K. R. Sandhya; Khadkikar, S. B.; Parikh, J. K.; Banerjee, B. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett.; 32B: 179-81(22 Jun 1970).

Deformed Hartree–Fock–Bogolyubov calculations were carried out for ^{46,48,50}Ti. The angular momentum projected spectra show a great improvement over the projected Hartree–Fock ones and are in very good agreement with the experimental results. (auth)

49848 PRECISION MEASUREMENTS OF THE HALFLIVES OF ^{27}Mg, ^{38}K, AND ^{43}Ca. Repace, James L. (Naval Research Lab., Washington, D. C.). Radiochim. Acta; 14: 46-9(1970).

Applications of activation analysis to a problem in marine biogeochemistry required remeasurement of the half-lives of ^{27}Mg, ^{38}K, and ^{43}Ca with improved precision. The weighted mean half-lives and probably errors obtained are 9.462 ± 0.012 m, 7.613 ± 0.011 m, and 8.719 ± 0.013 m, respectively. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 48064, 48065, 48124, 49259, 49299, 49692, 49742, 49778, 49790, 49796, 49818, 49830, 49839, 49845, 49919, 49931, and 49968.

49849 (AECL-3519) CALCULATED NEUTRON FLUX SPECTRA IN SAMPLES IRRADIATED IN A TRAY ROD FACILITY OF THE NRU REACTOR. Kushneriuk, S. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jan 1970. 66p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

Neutron flux spectra in the irradiation of milligram samples of plutonium and uranium oxide in a pneumatic facility of the NRU reactor are deduced and effective ^{235}U and ^{239}Pu nuclide absorption and fission cross sections in the spectra are calculated. The values derived are compared with values obtained from a g + rs type analysis and with the values obtained by B. R. Leonard, R. C. Litkala and U. P. Jenquin of Battelle-Northwest in their independent consideration of the irradiation. Estimates of the uncertainties in the cross sections due to the uncertainties in the specification of the neutron spectrum for the irradiation are also given. (auth)

49850 (AWRE-O-42/70) MEASUREMENTS OF $\bar{\nu}_p$ FOR ^{239}Pu BETWEEN 40 keV AND 1.2 MeV. Mather, D. S.; Bampton, P. F.; James, G.; Nind, P. J. (Atomic Weapons Research Establishment, Aldermaston (England)). Aug 1970. 12p. (EANDC(UK)-121-AL). Dep. CFSTI (U. S. Sales Only). UK 2s.

A large liquid scintillation counter was used to measure average values of prompt $\bar{\nu}$ for the neutron-induced fission of ^{239}Pu over 11 energy bands below 1.2 MeV. The energy bands were 40 to 115, 115 to 285, and 100 keV wide from 300 keV to 1.2 MeV. The relative accuracy was 1%. (auth)

49851 (BNL-tr-356) INVESTIGATION OF THE ALPHA SPECTRUM OF SHORT-LIVED RARE EARTH ISOTOPES. Mahunka, I. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Acta Phys. Acad. Sci. Hung.; 28: 229-35(1970). 13p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 38221.

49852 (CEA-N-1309) FISSION-PRODUCT CONCENTRATION AFTER THERMAL FISSION OF ^{235}U AND ^{239}Pu AND AFTER FAST FISSION (E ~ 1 MeV) OF ^{235}U, ^{238}U, AND ^{239}Pu. Barre, Bertrand; de Tourreil, Roland (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 107p. (In French). Dep. CFSTI (U. S. Sales Only).

Results of calculations made with the aid of the PEPIN LE BREF code and independent fission yield values used for these calculations are given. (France)

49853 (CEA-R-3936) INELASTIC SCATTERING OF 14 MeV NEUTRONS BY ^{239}Pu. Bertrand, Francoise; Voignier, Jacques (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Apr 1970. 40p. (In French). Dep. CFSTI (U. S. Sales Only).

The spectrum of 14-MeV neutrons scattered by plutonium-239 was studied by the time-of-flight method. The emission cross-section of inelastic neutrons was measured in the energy range 0.4 MeV to 8 MeV. The energy distribution of inelastic neutrons is represented by an expression of the type: $\sigma(E) = A.\ E \exp[(-E/T_e)] + B\sqrt{E} \exp[(-E/T_f)]$. The parameters A, B, T_e, and T_f were evaluated and compared with previous results. (auth)

49854 (COO-1746-35) MEASUREMENT OF THE E2/M1 AMPLITUDE RATIOS OF GAMMA TRANSITIONS IN THE EVEN-EVEN ISOTOPES OF Os AND Pt. Krane, K. S.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). [1970]. 5p. (CONF-700807-1). Dep. CFSTI.

From Conference on Angular Correlations in Nuclear Disintegration, Delft, The Netherlands.

The γ-γ directional correlations following the decays of ^{184,188,190}Ir and ^{194,196}Au were measured using high resolution Ge(Li) detectors and multichannel coincidence and routing techniques. The data were used to determine the E2/M1 amplitude ratios of gamma transitions in ^{186,188,190}Os and ^{194,196}Pt. The results are compared with microscopic calculations. (J.W.R.)

49855 (COO-1746-49) DIRECTIONAL CORRELATION MEASUREMENTS OF THE GAMMA RAYS EMITTED IN THE DECAY OF ^{160}Tb. Krane, K. S.; Steffen, R. M. (Purdue Univ., Lafayette, Ind. Nuclear Structure Lab.). [1970]. Contract AT(11-1)-1746. 21p. Dep. CFSTI.

The decay of ^{160}Tb to levels in ^{160}Dy has been investigated by measuring the gamma–gamma directional correlations using two 30 cc coaxial Ge(Li) detectors in conjunction with multichannel coincidence and routing apparatus. A detailed analysis was performed in order to correct for the effects on the measured correlations of Compton-scattered radiation. The result of the sixteen measured directional correlations served to verify the current spin assignments, and in addition yielded values for the E2/M1 and M2/E1 multipole mixing ratios of the gamma

transitions, given in terms of explicitly defined reduced matrix elements. Values obtained for the mixing ratios $\delta(\gamma)$ are (energies in keV): $\delta(215) = -0.18 \pm 0.10$, $\delta(299) = +0.005 \pm 0.010$, $\delta(392) = +0.005 \pm 0.070$, $\delta(765) = -(7^{+\infty}_{-2})$, $\delta(879) = -13.5 \pm 3.0$, $\delta(962) = -18.0 \pm 5.0$, $\delta(1178) = 0.02 \pm 0.02$, $\delta(1272) = -0.03 \pm 0.03$. The results are discussed in terms of collective rotational nuclear motion. (auth)

49856 (JINR-P3-5113) MEASUREMENT OF THE CROSS SECTION RATIO OF THE RADIATIVE CAPTURE AND (α) FISSION FOR ^{235}U AND ^{239}Pu IN THE RESONANCE REGION OF NEUTRON ENERGIES. Ryabov, Yu. V.; So Ton Sik; Chikov, N.; Kurov, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1970. 28p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The cross section ratio of the radiative capture and (α) fission for ^{235}U and ^{239}Pu is measured by the time-of-flight method in the neutron energy region of 0.1–30 keV with resolution of 60 nsec/m. (auth)

49857 (JINR-P6-5132) EXCITED STATES OF DEFORMED NUCLEI WITH 93, 95, AND 97 NEUTRONS. 2. THE DECAY ^{163}Tm → ^{163}Er. Abdurazakov, A. A.; Gromov, K. Ya.; Islamov, T. A.; Strusnyi, H. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 19p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The level scheme of ^{163}Er was investigated in the decay of ^{163}Tm, measuring the conversion electron spectrum and the gamma-ray spectra. The measurements of the conversion electron spectrum were performed with the aid of a magnetic beta-spectrograph with a resolution of 0.05%. The gamma-ray spectra were measured with germanium detectors. About 60 new transitions were observed. The multipolarities of the majority of gamma transitions were determined. Many of the gamma transitions were introduced into a level scheme of ^{163}Er. (auth)

49858 (JINR-P7-5164) SYNTHESIS OF ELEMENT 105. (SPONTANEOUS FISSION). Flerov, G. N.; Oganesyan, Yu. Ts.; Lobanov, Yu. V.; Lazarev, Yu. A.; Tret'yakova, S. P.; Kolesov, I. V.; Plotko, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 24p. (In Russian). Dep. CFSTI (U. S. Sales Only).

When bombarding ^{243}Am with ^{22}Ne ions an emitter of the spontaneous fission fragments with $\tau_{\frac{1}{2}} = (1.8 \pm 0.6)$ sec was recorded; its yield corresponds to the cross section $(5.0 \pm 1.5).10 - 34$ cm^2 for the branch of spontaneous fission. An integral angular distribution of the ^{243}Am + ^{22}Ne reaction products and the dependence of the production cross section of a new isotope on the ^{22}Ne energy are measured. It follows from these data and the analysis of the check experiment results that the atomic number of the isotope, being spontaneously fissionable with $\tau_{\frac{1}{2}} = (1.8 \pm 0.6)$ sec, is 105. The spontaneous fission of ^{256,257}103 isotopes was studied. It is shown that for these nuclei the half-life is more than 10^5 sec with respect to the spontaneous fission. The properties of the ^{255}103 isotope are discussed on the basis of experimental data. (auth)

49859 (JUL-643-FN) MEASUREMENT OF THE MASS DEPENDENCE OF ANISOTROPY AND YIELD OF PROMPT GAMMA RADIATION IN THERMAL FISSION OF ^{235}U. Labus, Herwig (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper- und Neutronenphysik). Feb 1970. 57p. (In German). Dep. CFSTI (U. S. Sales Only).

The yield and anisotropy of the prompt gamma radiation were studied as functions of the fission product mass for the thermal fission of ^{235}U. The target consists of a scintillation disc on which the uranyl acetate is evaporated. The energy of the fission products was measured with four silicon boundary layer detectors placed 90° from each other. These detectors give the stop signal for a time-of-flight analysis. The start signal was provided by a photomultiplier which observes the target over a light carrier system. The fission product mass is obtained from energy and time-of-flight. The prompt gamma radiation was recorded in four plastic detectors, which were arranged at angles of 30°, 90°, and 150° with respect to the flight direction of the fission products. A precision collimator was placed between the target and gamma detectors in order to separate the radiation escaping fission products and that of fission products stopped in the target. The mean emission time of the prompt gamma radiation detected through the collimator is given as 11 ± 3 psec. A method for the detection of emission times <5 psec from anisotrophy was given and a short-time component thus detected was discussed. Relative yields and anisotrophy of the prompt gamma radiation were measured without collimator as a function of the mass ratio and with collimator as a function of the fission product mass. In the mass range 90 to 100 and 135 to 145, the anisotrophy is constant within the measurement accuracy. The determination of the mass dependence of the angular momentum of fission products was made from the experimental data using two different models. (tr-auth)

49860 (LA-4369-TR) ANGULAR ANISOTROPY AND STRUCTURE OF THE FISSION BARRIER. Androsenko, K. D.; Ermagambetov, S. B.; Ignatiuk, A. V.; (and others). Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from report FEI-185. 15p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 30787.

49861 (ORNL-4581, pp 1-27) NUCLEAR CHEMISTRY. (Oak Ridge National Lab., Tenn.).

From chemistry division annual progress report for period ending May 20, 1970.
STD-4 P NSA

The decay of ^{43}Ca was studied. Energies and intensities of newly observed transitions in the γ spectra are tabulated. Experimental investigation of ^{86}Sr levels in the decay of 14.6-hr ^{86}Y was completed. A decay scheme for ^{86}Y based on coincidence measurements and other experimental data is proposed. Measurements indicated that the 0^+ member of the two-phonon state in ^{116}Cd exists at 1473.2 keV. The ^{116}Ag decay scheme is presented. An investigation of the level properties of ^{116}Cd as populated by the decay of 69-min ^{116}In was completed. A decay scheme for ^{114}In is given. Coincidence transitions were observed in the decay of ^{137}Nd, ^{136}Nd, and ^{136}Pr. Studies were continued on the production of rare-earth alpha emitters with energetic ^{3}He particles. Spectra obtained from reactions of ^{3}He with ^{156}Dy and ^{162}Er are given. Three new isotopes, ^{151}Er, ^{156}Yb, and ^{157}Yb, were characterized. Studies on properties of vibrational bands in ^{154}Gd and ^{158}Gd are underway. Preliminary results indicate an $87.4^{+1.1}_{-1.7}$% M1 radiation in the $2^+_\beta \rightarrow 2^+_\gamma$ transition in ^{170}Hf. (J.G.B.)

49862 (RPI-328-187) LINEAR ACCELERATOR PROJECT. Progress Report, January 1, 1970–March 31, 1970. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-1)-328. 86p. Dep. CFSTI.

Research progress is reported on: capture and transmission measurements on V, ^{58}Ni, ^{50}Cr, ^{52}Cr, ^{53}Cr, and ^{54}Cr; keV neutron capture measurements on ^{240}Pu; transmission measurements on ^{240}Pu; normalization of ^{235}U resonance $\bar{\nu}$ to thermal $\bar{\nu}$; 250-m neutron time-of-flight facility; neutron monitor for time-of-flight experiments; neutron average transmission and self-indication ratio measurements on Ta at room temperature; ^{235}U fission cross section; interactive transmission shape-fitting code for the IBM 1130; fast neutron spectra in Al; sodium assembly for fast neutron spectrum measurements; space-, time-, and energy-dependent neutron spectra calculations; fast reactor physics and engineering; instrumentation development; and systematics of photoneutron spectra. (M.C.G.)

49863 (TID-25540) MEASUREMENTS OF TRANSITION PROBABILITIES IN SOME MIDDLE WEIGHT NUCLEI. Kuebbing, Richard Andrew (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). Jan 1970. 61p. Dep. CFSTI. Thesis.

The level schemes of ^{92}Nb and ^{94}Nb were studied via the (p,n) reaction on separated zirconium targets. The pulsed beam of the ORNL 6-MeV Van de Graaff was used to measure the lifetimes of excited states of these nuclei. The 140.4-keV state in ^{94}Nb was found to have a half-life of (36.8 ± 0.4) nanoseconds by measuring the decay of the 99.4-keV gamma ray after the production of the state by the pulsed beam. The 226-keV state in ^{92}Nb was found to have a half-life of (5.2 ± 0.7) microseconds by measuring the decay of the 90.7-keV gamma ray in the same manner. The spins and parities of these states imply that they should be E1 transitions. They are slower, however, than Weisskopf estimates by factors of 8×10^{-6} and 6×10^{-6}, respectively. A simple explanation of this hindrance is proposed by invoking the shell model. A study of the decay of ^{83}Br to levels of ^{83}Kr was made to test the phonon character of the 0^+ excited state of ^{82}Kr. A search was made for the decay of this state by E0 conversion electron as predicted by Reiner. The energy spectrum of electrons from this source in coincidence with other radiations was measured, but no peak was seen. Methods for increasing the sensitivity of the experiment are discussed. (auth)

49864 (WANL-TME-1953) PROGRESS REPORT ON ANALYSIS OF ^{235}U RESONANCES ABOVE 62 eV. Drawbaugh, D. W.; Monkelis, M. R.; Remley, G. W. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Sep 1969. 58p. Dep. CFSTI.

Progress in an attempt to find a single level fit to neutron resonances in ^{235}U above 62 eV is reported. (J.W.R.)

49865 (WAPD-TM-935) GRAMP: A PROGRAM TO GENERATE REICH AND MOORE PARAMETERS FOR MULTILEVEL UNRESOLVED RESONANCES. Goldsmith, Mark (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1970. Contract AT-11-1-GEN-14. 14p. Dep. CFSTI.

GRAMP randomly generates Reich and Moore parameters for multilevel unresolved resonances of fissile isotopes. Parameters are calculated for two spin states of the compound nucleus. Associated with each of these states are two open fission channels. Punched card output which may be used directly as RECAP-O input is available on option. (auth)

49866 IDENTIFICATION OF ELEMENTS 102 AND 104 BY COLLIMATION METHOD. Oganesyan, Yu. Ts.; Lobanov, Yu. V.; Tret'yakova, S. P.; Lazarev, Yu. A.; Kolesov, I. V.; Gavrilov, K. A.; Plotko, V. M.; Poluboyarinov, Yu. V. At. Energ. (USSR); 28: 393-400(May 1970). (In Russian).

The experimental data on ^{102}[252] and ^{102}[256] isotope production in nuclear reactions induced by ^{16}O and ^{22}Ne ions, and production of element 104 by bombarding ^{242}Pu with ^{22}Ne ions are presented. It follows from the integral angular distributions that the spontaneously fissioning isotope, observed in the reaction ^{242}Pu + ^{22}Ne, is produced in the complete fusion reaction and hence has the atomic number 104. (auth)

49867 HALF-LIVES OF ^{196}Au AND ^{148}Pm AND THE MEASUREMENT OF HALF-LIVES BY γ-RAY SPECTROMETRY. Cabell, M. J.; Wilkins, M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 32: 1409-12(May 1970).

The gamma-ray spectra of sources of ^{196}Au and of the ground state of ^{148}Pm were measured as a function of time, by means of a sodium iodide scintillation detector. The half-lives of these nuclides were then calculated by fitting the measured areas of the photo-peaks produced by their 0.412 (^{196}Au) and 1.465 (^{148}Pm) MeV gamma-rays to untransformed exponential decay curves. "Best" fits were obtained by minimizing the sum of squares of the residuals weighted proportionally to the reciprocals of the variances of the areas produced by the fit. It is known that this method of analysis yields unbiased results provided that the data are accumulated over at least three half-lives. The mean of two unbiased estimates gave the half-lives of ^{196}Au and ^{148}Pm as 2.6946 ± 0.0010 days and 5.370 ± 0.009 days, respectively. (auth) (UK)

49868 DECAY OF RELATIVELY-SHORT LIVED NUCLIDES. Sugiyama, Kazusuke; Kotajima, Kyuya; Itagaki, Shinjiro; Takeda, Yasushi; Yamazaki, Naohiro (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 2, 69-88(Dec 1969).

The isotope of 9.5 min ^{138}La was produced by the (γ,3n) reaction on lanthanum using 60-MeV bremsstrahlung. The gamma radiations following the decay of the ^{138}La were investigated with a 36-cc Ge(Li) detector, and the following radiations (indicated by keV unit with relative intensities in parentheses) are observed: 551.0(W), 734.0(0.7), 759.8(15.6), 787.5(1.0), 817.2(100.0), 1270.0(2.0), 1306.4(3.6), 1320.0(13.8), 1492.3(2.4), and 1573.7(5.5). A decay scheme with levels at 817.2(2^+), 1573(2^+), 1604((0$^+$)), 2087, 2123, 2137, and 2309(keV) is proposed. (auth) (NSA of Japan)

49869 HALF LIVES FOR EXCITED STATES OF ^{97}Nb AND ^{97}Mo. Begzhanov, R. B.; Gladyshev, D. A.; Azimov, K. Sh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 44-7(1969). (In Russian).

Beta-γ and γ-γ coincidence spectra were measured for the decays of ^{97}Zr and ^{97}Nb. Decay schemes were constructed for both nuclei. Lifetimes were measured for levels at 1148, 1750, 1852, and 2106 keV in ^{97}Nb and for the 658-keV level in ^{97}Mo. (R.V.J.)

49870 CONTRIBUTIONS TO THE DECAYS OF ^{109}Pd AND ^{193}Pt. Bashandy, E. (Atomic Energy Establishment, Cairo). Z. Phys.; 236: 130-43(1970).

The gamma decays of 13.5-h ^{109}Pd to levels in ^{109}Ag and those of 30-min ^{193}Pt to levels in ^{193}Au have been studied with the use of both Ge(Li) gamma-ray and high-resolution iron-free double-focusing beta-ray spectrometers. The K-conversion coefficients and multipolarities of gamma-rays were determined. Spin and parity assignments for most of the levels were given on the basis of the conversion coefficients. The level structures of ^{109}Ag and ^{193}Au are discussed in terms of existing nuclear models. (auth)

49871 PROTON $(h_{9/2})^3$ CONFIGURATION IN ^{211}At. Bergstroem, I. (Research Inst. for Physics, Stockholm); Fant, B.; Herrlander, C. J.; Thieberger, P.; Wikstroem, K.; Astner, G. Phys. Lett.; 32B: 476-8(17 Aug 1970).

The nucleus ^{211}At has been studied in the ^{209}Bi(α,2nγ) reaction and in the EC decay of ^{211}Rn. Eight excited states belonging to the $(h_{9/2})^3$ configuration with spins from $^9/_2$ to $^{21}/_2$ have been identified. Three E2 effective charges are deduced which show no significant deviation from the corresponding values in ^{209}Bi and ^{210}Po. A high M1 hindrance is observed in three cases as expected within a j^n configuration. (auth)

49872 ENERGY OF THE ISOMERIC TRANSITION IN ^{235}U. Neve de Mevergniens, M. (CEN-SCK, Mol, Belg.). Phys. Lett.; 32B: 482-4(17 Aug 1970).

The conversion electron spectrum of ^{235}U^m has been measured, and it is concluded that the isomeric transition has an energy of 73 ± 5 eV and is converted in the PII, PIII, and PIV subshells. (auth)

49873 TIME DISTRIBUTION OF γ-RAYS FROM SPONTANEOUS FISSION OF ^{252}Cf. Skarsvag, K. (Institutt for Atomenergi, Kjeller, Norway). Nucl. Phys.; A153: 82-96(1970).

The gross time distribution and the absolute yield of γ-rays from spontaneous fission of ^{252}Cf were measured in the time range 0.1-120 ns after fission for γ-ray energies greater than 100 keV. The measurements were made by the recoil distance method for the shorter times, electronically for the longer times and electronically with a shield between the source and the γ-ray detector for the intermediate times. The absolute yield at 120 ns was found to be 11.6 ± 1.0 γ-rays per fission, of which 79% are emitted within 0.1 ns, 11.6% between 0.1 and 1.0 ns, 6.2% from 1 to 10 ns and 2.9% from 10 to 120 ns. (auth)

49874 HIGH-ENERGY PHOTON INDUCED SPALLATION REACTION IN ^{127}I. Jonsson, G. G.; Persson, B. (Univ. of Lund, Sweden). Nucl. Phys.; A153: 32-48(1970).

The yields for 28 different ^{127}I(γ,yp xn) reactions were measured by activation analysis from their thresholds up to 1 GeV. The mean cross sections in the energy region 250 to 900 MeV were determined. Photon and particle induced spallation cross-section distributions are compared using a five-parameter formula given by Rudstam and the significance of the different parameters are discussed. The mean total high-energy cross section is compared to the total free-nucleon photo-pion cross section. Some calculations on the basis of the cascade evaporation model were carried out. Some isomeric ratios are studied and finally the empirical cross-section formula is used to estimate some photon induced spallation cross sections. (auth)

49875 NEUTRON TRANSFER REACTIONS ON ^{204}Hg. Andersen, M.-L. (Copenhagen Univ.); Andersen, S. A.; Nathan, O.; Bisgard, K. M.; Gregersen, K.; Hansen, Ole; Hinds, S.; Chapman, R. Nucl. Phys.; A153: 17-31(1970).

The reactions ^{204}Hg(d,p)^{205}Hg and ^{204}Hg(d,t)^{203}Hg were investigated for E_d = 12 to 13 MeV, using magnetic spectrographs and photographic detection. Six excited states were observed in ^{205}Hg below 3.6 MeV and thirteen were found in ^{203}Hg below 1.8 MeV. The measured angular distributions were compared with DWBA predictions, and l-values and spectroscopic factors were determined for some of the levels. The data are compared with the corresponding reaction data for the lead nuclei. The nucleus ^{205}Hg appears to have some features in common with ^{207}Pb. In particular, one can identify a ^{205}Hg state at 1.853 MeV which probably corresponds to the 2.73 MeV $g_{9/2}$-2h-1p state of ^{207}Pb. The energy systematics of the $^1/_2^-$ and $^9/_2^+$ states near ^{206}Pb are discussed in terms of the pairing vibrational model. It is suggested that the change in excitation energy observed between the $g_{9/2}$ states of ^{207}Pb and ^{205}Hg is due mainly to the interaction between the proton-hole pair and the neutron-hole pair. (auth)

49876 EFFECT OF SPIN-DEPENDENCE OF FISSION WIDTH OF ^{239}Pu ON SELF-SHIELDING AND DOPPLER EFFECTS. Kikuchi, Yasuyuki; An, Shigerhiro (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 227-38(May 1970).

The effects of the spin-dependence of the fission width have been calculated for the self-shielding and Doppler effects. The spin-dependent fission widths derived from the channel theory are used in the calculation. Unusually strong spin-dependence is seen with ^{239}Pu. This spin-dependence of fission widths should significantly reduce the self-shielding and Doppler effects of the fission cross section, though the effect would be negligible for the other cross sections. The spin-dependent fission widths increase by more than 20% the negative Doppler coefficient of the ZPR-3 Assembly 48. The reactivity Doppler coefficient of 1 g of ^{239}Pu inserted in this system has also been calculated. The spin-dependent fission widths reduce the positive Doppler coefficient to one-tenth and contributes to reducing the discrepancies between the reported calculations and experiment. (auth)

49877 LIFETIMES OF HIGH-SPIN STATES IN DOUBLY EVEN Pt AND Hg ISOTOPES. Ton, H.; Dulfer, G. H.; Brasz, J.;

Kroondijk, R.; Blok, J. (Vrije Univ., Amsterdam). Nucl. Phys.; A153: 129–44(1970).

Lifetimes of $(4^-, 5^-)$ and $(6^-, 7^-)$ states in ^{194,196}Pt and ^{194,196,198,200}Hg were measured using the delayed coincidence technique. It turns out that in all cases the $(6^-, 7^-) \rightarrow (4^-, 5^-)$ E2 transitions are enhanced with about a factor 30. The hindrance factors of the $(4^-, 5^-) \rightarrow 4^+$ E1 transitions vary strongly from nucleus to nucleus. (auth)

49878 NEGATIVE PARITY STATES IN ^{190}Hg. Dulfer, G. H.; Ton, H.; Wigmans, M. E. J.; Verheul, H. (Vrije Univ., Amsterdam). Nucl. Phys.; A153: 121–8(1970).

Using delayed coincidence techniques a non-prompt level ($T_{\frac{1}{2}} = 6.9 \pm 0.2$ ns) was found in the decay of ^{190m}Tl to ^{190}Hg. Single and coincidence measurements were performed with Ge(Li) and Si(Li) detectors. Two new negative parity levels are proposed. The lifetime is attributed to the 7^- level at 1.6837 MeV. (auth)

49879 TRANSITION PROBABILITIES IN ^{188}Os. Malmskog, S. G. (Aktiebolaget Atomenergi, Studsvik, Sweden. Univ. of Stockholm); Berg, V.; Baecklin, A. Nucl. Phys.; A153: 316–36 (1970).

The level structure of ^{188}Os was studied from the decay of ^{188}Ir(13.3d) produced in proton spallation at CERN and mass separated in the ISOLDE on-line facility. The γ-ray spectrum has been recorded both with a high-resolution Si(Li) detector and Ge(Li) detectors. Three previously unreported transitions were observed defining a new level at 438.5 keV. Special attention was given to the low-energy level band structure. Several multipolarity mixing ratios were deduced from measured L-subshell ratios which, together with measured level half-lives, gave absolute transition probabilities. The low-level decay properties are discussed in terms of the Nilsson model with the inclusion of Coriolis coupling. (auth)

49880 STUDY OF REACTION MECHANISM AND PRODUCTION OF NEW ISOTOPES IN TRANSFER REACTIONS WITH HEAVY IONS. Artukh, A. G.; Gridnev, G. F.; Mikheev, V. L.; Wilczynski, J.; Volkov, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 140–51 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Some experiments on transfer reactions with heavy ions are reported. Studies indicated that the character of interaction of heavy ions with nuclei at energies higher than the Coulomb barrier is marked by the impact parameter or by the angular momentum of relative motion. The reactions of the pick-up of nucleons by irradiation ^{27}Al, ^{51}V, and ^{93}Nb with ^{16}O ions were studied at 137, 126, and 131 MeV, respectively. Transfer reactions with heavy ions could be used for the production of isotopes of light elements far away from the stability line. The yield of isotopes of light elements produced in the irradiation of ^{232}Th with ^{16}O ions is shown. ^{19}O, ^{20}O, ^{21}O, ^{22}O, ^{18}C, and ^{20}N are among the isotopes formed. An irradiation of ^{232}Th with ^{11}B ions was carried out at 87 MeV. (M.C.G.)

49881 THEORY OF HEAVY ION AND FISSION REACTIONS. Syros, C. (European Atomic Energy Community, Brussels). pp 210–13 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

By applying a theorem of very general validity to the case of two colliding ions, important conclusions may be deduced about the symmetry properties of the reaction products. Conversely, the symmetry states of the ions that favor fusion or are favored by fission can be found. An attempt was made to design how the elements of a quantum-mechanical fission theory should present themselves in the framework of the quasi-molecular hypothesis. (M.C.G.)

49882 IMPLANTATION PERTURBED ANGULAR CORRELATION STUDIES ON ^{238}U IN IRON. Kaufmann, E. N.; Lie, H. P.; Murnick, D. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 424–30 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Perturbed angular correlations after Coulomb excitation and recoil implantation by heavy ions were used for the first measurement of the hyperfine interaction at uranium in iron. The $I^\pi = 2^+$, 4^+, and 6^+ levels of the well-developed ground state rotational band in ^{238}U were Coulomb excited by 80 MeV ^{32}S ions. The results indicate a hyperfine field at uranium in iron of $-(520 \pm 155)$ kOe and are consistent with a precession arising from the transient field effect on the recoiling uranium ion in iron. (M.C.G.)

49883 MAGNETIC HYPERFINE FIELD OF URANIUM IN IRON. Muenchow, C. (Univ. of Copenhagen); Waddington, J. C.; Herskind, B.; Ravn, H.; Deutch, B. I. pp 435–7 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A sulfur beam was used to Coulomb excite the first 4^+ state in ^{238}U. The de-exciting gamma rays were measured in coincidence with back-scattered particles. Thus, angular correlations were determined for uranium implanted into iron and copper. (M.C.G.)

49884 NEUTRON EVAPORATION IN HEAVY ION INDUCED REACTIONS. Sperber, Daniel (Rensselaer Polytechnic Inst., Troy, N. Y.). pp 684–6 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

A rigorous method is suggested for the calculation of the excitation function for evaporation of a specified number of neutrons in heavy-ion-induced reactions in which fission competes with neutron evaporation. (M.C.G.)

49885 POTENTIAL ENERGY SURFACES IN HEAVY ION PHYSICS. Greiner, Walter (Univ., Frankfurt am Main). pp 748–80 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Examples of potential energy surfaces that belong to fission-type reactions (adiabatic) and those corresponding to high-energy ion–ion scattering (nonadiabatic) are discussed. The collective potential energy surfaces in the region of superheavy nuclei within an extrapolated shell model were calculated. The deformations of the ground states, the locations and heights of the fission barriers, the stability against α and β decay are discussed. (M.C.G.)

49886 SEARCH FOR SUPERHEAVY ELEMENTS IN NATURE. Zvara, Ivo (Joint Inst. for Nuclear Research, Dubna, USSR). pp 784–94 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Where and how to search for heavy elements are discussed. Predictions of chemical properties and geochemical behavior of these elements are considered. Experiments at Dubna are described. Superheavy elements in cosmic rays are estimated. (M.C.G.)

49887 SEARCH AND IDENTIFICATION OF NUCLEI IN THE MASS REGION 260 TO 310. Lefort, M.; Jacmart, J. C.; Peter, J.; Riou, M.; Roynette, J. C.; Stephan, C.; Tarrago, X. (Institut de Physique Nucleaire, Orsay, France). pp 795–8 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The search for superheavy elements of Z between 112 and 126 is described. The nuclear reactions for producing superheavy elements and identification of the mass of the recoiling nuclei are considered. (M.C.G.)

49888 STABILITY OF SUPERHEAVY NUCLEI AGAINST ELECTRON-CAPTURE. Morovic, Tihomir (Univ., Frankfurt am Main). pp 799–801 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The stability of odd A superheavy nuclei against electron capture was investigated. (M.C.G.)

49889 FISSION AND SPONTANEOUS FISSION ISOMERS BY COULOMB EXCITATION. Beyer, Karin (Univ. of Copenhagen); Winther, Aage; Smilansky, Uzy. pp 804–6 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Quantum mechanical calculations of conditions under which fission will occur were extended to include rotational motion. The only intrinsic degree of freedom considered is still the β deformation. Results are demonstrated for the case of back-scattering of heavy ions from a ^{234}U target. (M.C.G.)

49890 GAMMA-RAY MEASUREMENTS WITH A BENT-CRYSTAL SPECTROMETER. Reierson, J. D.; Nelson, G. C.; Hatch, E. N. (Iowa State Univ., Ames). Nucl. Phys.; A153: 109-20(1970). (IS-T-290).

A two-meter bent-crystal spectrometer was used to obtain high-precision γ-ray energy and relative intensity values. Low-energy transitions following the decay of ^{128}I, ^{152}Eu, ^{155}Sm, ^{155}Eu, ^{175}Yb and ^{180m}Hf were investigated. From the relative intensities of the ^{175}Yb γ-rays and the Lu K x-rays a value of 1.90 ± 0.08 was obtained for the K conversion coefficient for the 113.8 keV transition in ^{175}Lu. The ^{180}Hf level energies of 93.332 ± 0.006 keV (2^+), 308.583 ± 0.014 keV (4^+), 640.89 ± 0.04 keV (6^+) and 1084.07 ± 0.06 keV (8^+) are compared with several models. The decay of ^{155}Eu to ^{155}Gd is discussed. (auth)

49891 g FACTORS OF THE FIRST TWO EXCITED 2^+ STATES IN ^{192}Pt. Grabowski, Z. W. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1746. Phys. Rev., C; 2: 1093-6(Sep 1970).

The g factors of the first and the second excited 2^+ state in ^{192}P have been measured by observing the integral rotation of the directional correlation pattern in the internal magnetic field acting on Pt nuclei implanted in an iron host. Both values, $g_{31e} = 0.27 \pm 0.02$ and $g_{41e} = 0.30^{+0.06}_{-0.04}$, are higher than those predicted by the pairing-plus-quadrupole model of Kumar and Baranger. (auth)

49892 ^{141}Pr(γ,n) CROSS SECTION FROM THRESHOLD TO 24 MeV. Sund, R. E.; Verbinski, V. V.; Weber, Hans; Kull, L. A. (Gulf General Atomic Inc., San Diego, Calif). Contracts Nonr-4024(00); N00014-69-C-0064. Phys. Rev., C; 2: 1129-37(Sep 1970).

The ^{141}Pr(γ,n) cross section was measured from threshold to 24 MeV with a photon beam produced by the in-flight annihilation of positrons. The photon beam resolution was determined to be 1.2% (full width at half maximum) by elastically scattering the γ rays from the 15.1-MeV level in ^{12}C. The (γ,n) cross section was found to have a maximum value of ~348 mb and an integrated value up to 24 MeV of 1.72 ± 0.16 MeV b. Within the statistics and the photon resolution of the measurement, the results indicate that there is no structure in the cross section, with the possible exception of a weak bump at approximately 17.5 MeV. The results are compared with previous measurements and with theory; the latter comparison indicates that the widths of states in the dynamic collective theory should be considerably broader than those which have been typically used. (auth)

49893 ENERGY LEVELS OF ^{195}Au. Goldman, L. H.; Cohen, B. L.; Moyer, R. A.; Diehl, R. C. (Univ. of Pittsburgh). Phys. Rev., C; 2: 561-5(Aug 1970).

The energy levels of ^{195}Au were studied by observation of conversion electrons following the (p,2n) reaction on ^{196}Pt and by measurement of the energy spectrum and angular distribution of tritons from the ^{197}Au (p,t) reaction. Many new energy levels are reported, and several new I-π assignments are made by combining information from the two experiments. (auth)

49894 ANGULAR CORRELATIONS IN THE DECAY OF ^{192}Ir. Seubert, J. W.; Wilkinson, R. G. (Indiana Univ., Bloomington). Phys. Rev., C; 2: 721-3(Aug 1970).

The $\beta-\gamma$ angular correlation of the (536-keV-β)–(604-keV-γ + 612-keV-γ) transition in ^{192}Ir was measured and found to be zero. The $\gamma-$conversion-e^- correlation of the 604-keV–361-keV transitions in ^{192}Pt was used to estimate the E2/M1 mixing ratio of the 605-keV γ ray, giving $\delta = 3$. (auth)

49895 NUCLEAR MATRIX ELEMENTS IN THE DOUBLE BETA DECAY ^{130}Te → ^{130}Xe. Huffman, Arthur H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 2: 742-7(Aug 1970).

The nuclear matrix element for the double β decay ^{130}Te → ^{130}Xe is calculated with a specific Gamow–Teller force. A reasonable strength of this force is unable to give enough reduction in the rate to agree with the experimental half-life. The amount of isospin violation in the wave function owing to the difference of the neutron and proton single-particle energies is calculated. The number and isospin problems are discussed in connection with the use of the random-phase approximation in a β-decay calculation. It is shown that the β-decay operator has no spurious terms due to number or isospin dispersion. (auth)

49896 NEUTRONS EMITTED IN SPONTANEOUS FISSION OF ^{246}Cm. Thompson, Major C. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Phys. Rev., C; 2: 763-4(Aug 1970).

The value of $\bar{\nu}$ for ^{246}Cm was found to be 3.20 ± 0.22 in a BF_3 proportional counter calibrated with a ^{252}Cf standard. (auth)

49897 HALF-LIFE OF THE LOW-LYING $\frac{1}{2}^+$ LEVELS IN ^{123}I AND ^{121}I. Schrader, H. (Technische Hochschule, Brunswick); Stippler, R.; Muennich, F. Nucl. Phys.; A151: 331-6(1970).

The half-life of the low-lying $\frac{1}{2}^+$ levels in ^{123}I and ^{121}I has been measured by delayed coincidence techniques. The following results were obtained: ^{123}I (148.9 keV), $T_{\frac{1}{2}} = 2.44 \pm 0.09$ ns; ^{121}I (95.7 keV), $T_{\frac{1}{2}} = 8.3 \pm 0.4$ ns. The transition rates correspond to 20 and 25 single-particle units, respectively. (auth)

49898 SOME CUMULATIVE MASS YIELDS FROM THE FISSION OF ^{230}U BY 3-MeV NEUTRONS. Lyle, S. J.; Wellum, R. (Univ. of Kent, Canterbury, Eng.). Radiochim. Acta; 13: 167-8(1970).

The sample irradiated was usually 10 g of $UO_2(NO_3)_2 \cdot 6H_2O$. All mass yields were measured relative to mass-99. Chemical separations were made and decay curves obtained. Data are presented in tables. (M.C.G.)

49899 ^{261}Rf: NEW ISOTOPE OF ELEMENT 104. Ghiorso, A.; Nurmia, M.; Eskola, K.; Eskola, P. (Univ. of California, Berkeley). Phys. Lett.; 32B: 95-8(8 Jun 1970).

A 65 s, α-particle emitting isotope of element 104, rutherfordium, was discovered by bombarding ^{248}Cm with ^{18}O ions. The identification of the isotope as ^{261}Rf is based on milking the 26 s daughter, ^{257}No. (auth)

49900 SPIN OF THE 921 keV LEVEL IN ^{99}Tc. Gfirtner, H.; Naumann, H.-R.; Schneider, H. (Justus Liebig-Univ., Giessen, Ger.). Z. Phys.; 235: 431-5(1970). (In German).

The angular correlation of the ^{99}Tc 739–181 keV gamma–gamma cascade was measured in a liquid molybdenum source. The result was: $A_2 = 0.0930 \pm 0.0028$, $A_4 = -0.0095 \pm 0.0042$. The spin of the 921 keV level was determined to $\frac{7}{2}^+$. The mixing ratio of the 739 keV gamma-transition was measured to δ (E2/M1) = 5.9. (auth)

49901 DECAY OF ^{140}Pr TO LEVELS IN ^{140}Ce. Jacobs, E.; De Frenne, D.; Uyttenhove, J. (Rijksuniversiteit, Ghent). Z. Phys.; 235: 395-402(1970).

The decay of ^{140}Pr was investigated by means of a Ge(Li) spectrometer. Excited states of ^{140}Ce at 1,596.2, 1,903.1, 2,348.9, 2,522.5, 3,016.8 and 3,119.6 keV are fed in the beta decay of ^{140}Pr. Spin and parity assignments for all observed levels were made from electron capture and positron disintegration considerations and gamma branches. The experimental level scheme of ^{140}Ce is compared with the results of shell model calculations for N = 82 nuclei. (auth)

49902 BETA SPECTRUM SHAPES AND BETA NUCLEAR MATRIX ELEMENTS OF THE $1^- \rightarrow 0^+$ TRANSITIONS OF ^{186}Re AND ^{188}Re. Andre, S.; Liaud, P. (Univ., Grenoble, France CEA, Grenoble, France). J. Phys. (Paris); 31: 155-61(Feb-Mar 1970). (In French).

The β spectrum shapes of the $1^- \rightarrow 0^+$ transitions leading to the ground states of ^{186}Os and ^{188}Os were measured. With these results and other available experimental data, the β nuclear matrix elements were determined. The results are compared with the predictions of rotational model theories and the experimentally determined value of $\Lambda = \int 1a/\xi \int r$ with the different theoretical estimates. (auth) (France)

49903 PERTURBATIONS OF THE ALPHA–GAMMA ANGULAR CORRELATION IN THE DECAY OF ^{226}Ra. Orre, B.; Linnfors, A.; Falk, F.; Thun, J. E.; Johansson, L. (Uppsala Univ.). Nucl. Phys.; A148: 516-28(1970).

The gyromagnetic ratio for the first excited (2^+) rotational state (185.7 keV, $T_{\frac{1}{2}} = 0.32$ ns) in ^{222}Rn has been obtained by the technique of perturbed $\alpha-\gamma$ angular correlations. The result $g_R = 0.45 \pm 0.07$ is somewhat larger than $Z/A \approx 0.39$. The average internal magnetic field of radon atoms recoiling into nickel was found to be 15 ± 3 kG and positive. The perturbations in different environments were studied by observing the coincidence rate in 180° between α and γ. In vacuum the perturbations were severe but could be decoupled in a parallel magnetic field. A number of solids were examined and the perturbations were in general small. In all measurements thin sources were used. The thickness of one typical source was deduced from the energy loss of α-particles. (auth)

49904 TOTAL NEUTRON CROSS SECTION FOR ^{232}Th IN THE ENERGY REGION 1.5 TO 8.5 MeV. Pasoli, U. (Univ., Padua. INFN, Padua); Toniolo, D.; Zago, G.; Zuffi, L. Nucl. Phys.; A151: 369-76(1970).

The total neutron cross section for ^{232}Th has been measured in

the energy region 1.5 to 8.5 MeV. The experimental data have been analyzed in terms of a nonspherical optical potential. (auth)

49905 HALF-LIFE OF ^{115m}Ag. Weiss, H. V. (Naval Undersea Research and Development Center, San Diego, Calif.); Ballou, N. E. J. Inorg. Nucl. Chem.; 32: 2781-2(Aug 1970).

This half-life has been variously reported as 20 ± 10 sec and 49 ± 6 sec, and in view of this disparity a further determination was made. ^{115m}Ag from the fission of ^{235}U was rapidly separated from its Pd precursor and Cd daughter products by an exchange reaction, and at intervals after the separation the ^{115g}Cd activity formed by the decay of the two ^{115}Ag isomers was milked and measured. Milking was effected by stripping the ^{115g}Cd from the radiosilver, deposited on copper oxide, by working with 0.1 N HNO_3. The values obtained for the half-life of ^{115m}Ag were 55.8 and 55.0 sec in two separate experiments. (UK)

49906 ^{132}Sn HALF-LIFE AND FRACTIONAL CUMULATIVE YIELD FROM THERMAL-NEUTRON INDUCED FISSION OF ^{235}U. Lin, Chien-chang; Wahl, Arthur C. (Washington Univ., St. Louis). Contracts AT(11-1)-1162; AT(11-1)-1760. J. Inorg. Nucl. Chem.; 32: 2501-7(Aug 1970).

The half-life and fractional cumulative yield of ^{132}Sn were determined to be 2.1 ± 0.2 min and 0.32 ± 0.03, respectively. The yield was considerably larger than had been estimated and may have been enhanced due to stabilization resulting from nucleon pairing and shell closures. (auth) (UK)

49907 STRUCTURE IN THE FISSION CROSS-SECTION OF ^{234}U. Patrick, B. H.; Sowerby, M. G.; Schomberg, M. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 24: 269-73(Sep 1970).

The neutron-induced fission cross section of ^{234}U was measured from 50 eV to 30 keV with a nominal resolution of 2 nsec/m. Pronounced structure which is observed in the keV region is attributed to fission occurring through levels in the second minimum in the potential well. It is shown, by using other published information, that the structure continues up to at least 166 keV. (auth) (UK)

49908 ANGULAR DISTRIBUTIONS OF FRAGMENTS FROM ^{235}U(n,f) REACTIONS NEAR THE THRESHOLD. Lo Nigro, S.; Milone, C. (Univ., Catania, Italy. INFN, Siciliana, Italy). Nucl. Phys.; A151: 182-6(1970).

The angular distributions of fragments from neutron-induced fission of ^{235}U in the range $1.2 < E_n < 2.66$ MeV are measured by means of nuclear emulsions. From the analysis of the angular distributions information is obtained on the sequence of K-bands that contribute to the ^{235}U(n,f) reaction near the threshold. (auth)

49909 STATIC ELECTRIC QUADRUPOLE MOMENTS OF THE FIRST EXCITED STATES OF ^{144,146,148,150}Nd. Gertzman, H. S.; Cline, D.; Gove, H. E.; Lesser, P. M. S. (Univ. of Rochester, N. Y.). Nucl. Phys.; A151: 282-94(1970).

From the relative yield of γ-rays deexciting the 2^+ first excited states of ^{144,146,148,150}Nd following Coulomb excitation by helium, oxygen and sulfur ions, it has been possible to measure the relative static quadrupole moments of these states. Ratios of the γ-ray yields for different projectiles were compared with the calculations of a Coulomb excitation coupled channels computer code. Absolute quadrupole moments of +0.03 ± 0.21, −0.63 ± 0.10 and −1.24 ± 0.14 e · b were obtained for ^{144,146,148}Nd, respectively, if the rotational value of −1.48 e · b is assumed for the quadrupole moment of ^{150}Nd. Best agreement with the quadrupole moments of ^{144,146,148}Nd (measured by Crowley) is obtained assuming $Q_{2^+} = 2.00 \pm 0.51$ e · b for ^{150}Nd. Corresponding to this value for ^{150}Nd, the quadrupole moments for ^{144,146,148}Nd are −0.07 ± 0.15, −0.78 ± 0.09 and −1.46 ± 0.13 e · b, respectively. A comparison with previously published data on the quadrupole moments for neighboring nuclei shows a smooth increase in the magnitude of the (negative) quadrupole moments of the first 2^+ states as one adds pairs of neutrons or neutron holes to the closed neutron shell at N = 82. The static quadrupole moments for ^{148}Nd and ^{150}Nd exceed the rotor value, derived from the B(E2, $0^+ \rightarrow 2^+$), by about 37%. Similar results have been observed in previous reorientation measurements on rotational nuclei and are not understood at the present time. (auth)

49910 ANGULAR ANISOTROPY OF FRAGMENTS IN THE TERNARY FISSION OF ^{233}U AND ^{235}U INDUCED BY 14 MeV NEUTRONS. Kovacs, I.; Nagy, L.; Vinnay, L.; Kluge, Gy. (Central Research Inst. for Physics, Budapest). Nucl. Phys.; A153: 652-6(1970).

Angular anisotropy measurements on fission fragments from α-particle accompanied ternary fission relative to that observed during binary fission are reported. The angular distribution of the ternary fission fragments measured at angles 0° and 90° to the incident neutron beam shows a higher anisotropy than that of binary fission fragments for both ^{238}U and ^{235}U targets. (auth)

49911 TRITIUM YIELD IN THE THERMAL NEUTRON FISSION OF ^{233}U. Horrocks, D. L.; White, E. B. (Argonne National Lab., Ill.). Nucl. Phys.; A151: 65-70(1970).

Tritium produced by the thermal neutron fission of ^{233}U in the Argonne CP-5 reactor thermal isotope tray was isolated chemically and measured with a liquid scintillation counter. One tritium atom was measured for every $(1.10 \pm 0.07) \times 10^4$ fission events. (auth)

49912 STUDIES OF THE α-ACTIVE ISOTOPES OF MERCURY, GOLD, AND PLATINUM. Hansen, P. G. (Univ. of Arhus, Denmark); Nielsen, H. L.; Wilsky, K.; Alpsten, M.; Finger, M.; Lindahl, A.; Naumann, R. A.; Nielsen, O. B. Nucl. Phys.; A148: 249-72(1970).

Neutron-deficient isotopes of mercury were produced by isotope-separation-on-line techniques. Alpha emission was established from all mass numbers 179 to 187. The α-decay energies were measured, as were the half-lives except for ^{179}Hg. Fine structure in the α spectra was observed in 6 cases. The partial α lifetime was determined for 11 α transitions from mercury isotopes. The α decay was also studied for isotopes of gold and platinum, which were found as daughters of the mercury isotopes. Previous assignments of α-decay energies and half-lives to mass numbers were confirmed. Alpha-emission was found for the first time from ^{184}Au and, tentatively, from ^{182}Au. Fine structure was seen in the α spectra from ^{184}Au, ^{178}Pt, and ^{177}Pt. The α lifetime was determined for 9 transitions from isotopes of gold and platinum. The measured α-decay energies were compared to recent mass calculations. The energy of the first excited 2^+ level was determined in the even nuclei ^{180}Pt(159 ± 5 keV), ^{178}Pt(169 ± 5 keV), and ^{174}Os(152 ± 5 keV). A systematic dependence of α-transition rates on neutron and proton number is pointed out. (auth)

49913 STATIC QUADRUPOLE MOMENTS OF FIRST 2^+ STATES OF SPHERICAL NUCLEI IN A SCHEMATIC MODEL. Birbrair, B. L. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 32B: 165-8(22 Jun 1970).

A general expression is derived for the γ-transition matrix element between correlated two-quasiparticle states. Static quadrupole moments of first 2^+ ("one-phonon") states and reduced probabilities of a direct E2-decay of second 2^+ ("two-phonon") ones in Ru, Pd and Cd isotopes are calculated in a simple schematic model of single-quasiparticle states. (auth)

49914 LEVEL SCHEMES AND PROPERTIES OF THE ODD-MASS Sb ISOTOPES. Vanden Berghe, G.; Heyde, K. (Univ., Ghent). Phys. Lett.; 32B: 173-6(22 Jun 1970).

Level schemes of ^{117,119,121}Sb are calculated in a unified-model approach with surface vibrations coupled to the proton single-particle motion. The addition of octupole vibrations is necessary to explain low-lying negative parity states. Reaction data are calculated. (auth)

49915 QUADRUPOLE MOMENT OF THE FIRST EXCITED STATE IN ^{114}Cd. Andreev, D. S.; Gusinskii, G. M.; Erokhina, K. I.; Kudoyarov, M. F.; Lemberg, I. Kh.; Chugunov, I. N. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 32B: 187-9 (22 Jun 1970).

The quadrupole moment of the first excited state in ^{114}Cd was measured. A new method eliminating correlation effects yields $Q(2^+) = -0.53 \pm 0.17$ b. (auth)

49916 INVESTIGATION OF THE PROPERTIES OF THE SPONTANEOUSLY FISSIONING ISOMER ^{241}Pu IN THE REACTION (γ,n). Gangadii, Yu. P.; Markov, B. N.; Tsipenyuk, Yu. M. (Inst. for Physical Problems, Moscow). Phys. Lett.; 32B: 182-4(22 Jun 1970).

The reaction ^{243}Pu(γ,n) was studied in which a spontaneously fissioning isomer ^{241}Pu was formed with 23 ± 1s half-life. The ratio of the cross sections for formation of the isomeric state and the ground state of ^{241}Pu was measured as $(9 \pm 2) \times 10^{-4}$ along with the threshold for the formation of the isomeric state (9.10 ± 0.15 MeV). From the comparison of the thresholds for the formation of the ground state and the isomeric state the excitation energy of the spontaneously fissioning ^{241}Pu isomer was determined as −2.9 ± 0.15 MeV. The data obtained are compared with the analysis of subbarrier resonances in the reaction ^{240}Pu(n,f). (auth)

49917 BETA DECAY OF ^{99m}Tc. Jones, J. D.; Griffin, H. C. (Univ. of Michigan, Ann Arbor). Radiochem. Radioanal. Lett.; 4: 381-4(24 Sep 1970).

Evidence of the branching decay of ^{99m}Tc by β transition in a small fraction /9.7 ± 1.5/ × 10^{-7} of the ^{99m}Tc atoms was determined. Results of γ measurements of a shielded source of high-purity ^{99m}Tc revealed a γ ray at 322.4 keV ± 0.2 keV. This γ ray

which follows the half-life of ^{99m}Tc, is explained by the beta decay of ^{99m}Tc to ^{99}Ru ground state. (auth)

Nuclear Theory

Refer also to abstracts 49373, 49398, 49425, 49439, 49543, and 49754.

49918 (CEA-R-3950) THEORETICAL INTERPRETATION OF MEDIUM-ENERGY NUCLEON–NUCLEUS INELASTIC SCATTERING. Lagrange, Christian (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jun 1970. 54p. (In French). Dep. CFSTI (U. S. Sales Only).

A theoretical study is made of the medium energy nucleon–nucleus inelastic scattering (direct interaction), by applying the distorted wave Born approximation as deduced from the coupled equation method. This is used to interpret the inelastic scattering of 12-MeV protons by ^{63}Cu. Different sets of wave functions are used to describe the various states of the target nucleus. The nature of these states and the shape of the nucleon–nucleus interaction potential, are analyzed; the results are compared with those obtained from other theoretical and experimental works. (auth) (France)

49919 (CEA-R-4000) MICROSCOPIC MODEL FOR INELASTIC SCATTERING OF MEDIUM-ENERGY PROTONS. Schaeffer, Richard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1970. 143p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, Orsay, France.

The microscopic description of inelastic proton scattering is usually made in the DWBA approximation using an effective two-body force which acts between the incident nucleon and the excited particle in the target, and which is fitted to the experimental data. Such an approach leads however to poor angular distributions, except when using rather short range forces, and the effective strength has a tendency to increase for large spin transfer and to depend on energy. The exchange effects arising from antisymmetrization of the incident particle and target wave functions and also from the exchange nature of the nuclear forces are taken into account. This model predicts the experimental magnitude of the cross sections without any adjustable parameter for inelastic scattering when the bound state description is good. In particular, it explains the spin and energy dependence of the experimental cross-section strengths. An expression is derived for the T matrix in the DWBA approximation for antisymmetrized wave functions, taking into account the fast that the potential well for free particles is complex. The DWBA transition amplitude is expressed in terms of the antisymmetrized two-body matrix elements of the nucleon–nucleon interaction. Considering nuclei with at least one closed shell, the most recent microscopic descriptions for the lowest excited collective states are discussed. The ground state is described in the BCS scheme and the excited states are made of one particle-one hole and two quasiparticle excitations in the Tamm–Dancoff or Random Phase approximations. Some very simple models are developed in order to discuss the physical features of the pp' excitations. The mechanisms by which the inelastic scattering occurs are demonstrated and the sensitivity of the results to only a few nucleon–nucleon parameters is explained. In order to test the validity of our model, the excitation of the T = 0 collective states of doubly closed shell nuclei where good microscopic wave functions are available were chosen. Without any adjustable parameters, and using a force which fits free low energy nucleon–nucleon scattering, the magnitude of the experimental cross sections to the excited states of ^{12}C, ^{40}Ca, and ^{208}Pb at several different energies were reproduced. Exchange effects increase the cross sections by a factor 2 to 10. Their strong energy and spin dependence is seen to be needed in order to explain the experimental results. The improvement of the angular distributions is however small. (auth)

49920 (CEA-R-4015) THEORY OF NUCLEAR DEFORMATIONS IN PRESENCE OF TWO-HOLE, TWO-PARTICLE CORRELATIONS. Padjen, Radovan (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1969. 97p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, Orsay, France.

The problem of two-hole (2p-2h) admixtures is studied and applied to even–even N = Z 2s-1d shell nuclei. A proper diagonalization corresponding to a resummation of Goldstone diagrams is derived. The problem of spurious effects, such as the non-conservation of angular momentum, is studied and a method is devised to check the validity of approximate eliminations of spurious effects. The effect of 2p-2h admixtures on the equilibrium deformation is first studied in a simplified calculation using Nilsson orbits. Then a fully self-consistent theory is formulated of the static average field in the presence of 2p-2h admixtures. A topological analysis of Goldstone diagrams, due to C. Bloch, yields a simple stationary expression for the ground state energy. The theory is illustrated by a complete numerical application in the 2s-1d shell. (auth)

49921 (COO-535-613) ALGEBRA USED BY DWUCK WITH APPLICATIONS TO THE NORMALIZATION OF TYPICAL REACTIONS. Kunz, P. D. (Colorado Univ., Boulder. Dept. of Physics). Jul 1970. Contract AT(11-1)-535. 9p. Dep. CFSTI.

The computer program DWUCK, which calculates the scattering differential cross section in the zero-range DWBA, is described. The equations used are given in full. Applications to inelastic scattering stripping, and pick-up reactions are illustrated. (J.W.R.)

49922 (COO-1746-44) DETERMINATION OF FIRST FORBIDDEN BETA MATRIX ELEMENTS FROM ANGULAR CORRELATION DATA. Simms, Paul C. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1970]. 15p. (CONF-700807-2). Dep. CFSTI.

From Conference on Angular Correlations in Nuclear Disintegration, Delft, The Netherlands.

A method for the extraction of first-forbidden beta matrix elements from angular correlation data is discussed. Some examples are given. (J.W.R.)

49923 (EURFNR-786) NEUTRON TOTAL, SCATTERING AND (n,x) REACTION CROSS SECTIONS ABOVE THE RESONANCE REGION. Cierjacks, S. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). May 1970. 30p. (KFK-1201; IAEA-CN-26/113; CONF-700605-5). Dep. CFSTI (U. S. Sales Only).

From 2nd International Conference on Nuclear Data for Reactors, Helsinki, Finland.

The present status of neutron facilities used for fast neutron cross section measurements is surveyed. A few topics are then discussed in some detail. In the important area of total neutron cross sections, several examples of new high resolution data are shown. Comparisons of other data with optical model calculations are also considered. Scattering cross section measurements are reviewed and the sphere transmission method, associated γ-ray method and time-of-flight method are discussed. Finally the area of (n,x) reaction cross sections is briefly reviewed. Concluding remarks are made concerning the accuracy of presently available data. (auth)

49924 (IAE-1879) CONCERNING THE SOLUTION OF THE PROBLEM OF FEW NUCLEONS. Efros, V. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1969. 30p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The methods of solving the few-nucleon problem with realistic forces based on the K-harmonics method are developed. (auth)

49925 (ITF-70-31) VARIATION-ITERATIONAL CALCULATION OF THE THREE NUCLEONS BINDING ENERGY. Antonchenko, V. Ja.; Simenog, I. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 14p. Dep. CFSTI (U. S. Sales Only).

The wave functions of the strong coupling constant method of a series of inverse coupling constant are used as the test functions to calculate the three nucleon ground state energy. An analysis of the energy dependence on the function approximation order was carried out for several simple paired potentials. A simple interpretation of variation parameters is given, and the mean-square radii and form factors are calculated. (auth)

49926 (JAERI-1191) STAX 2: A COMPUTER PROGRAM FOR CALCULATING NEUTRON ELASTIC AND INELASTIC SCATTERING CROSS SECTIONS BY MEANS OF THE OPTICAL MODEL AND MOLDAUER'S THEORY. Tomita, Yoshiaki (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Jul 1970. 27p. Dep. CFSTI (U. S. Sales Only).

The program computes the cross sections for neutron elastic and inelastic scattering using the optical model and Moldauer's theory, and searches for potential parameters which reproduce experimental cross sections. Improvement is made in the treatment of the effect of resonance interference. The quantity "Q" characterizing this effect has been regarded as an arbitrary parameter in the calculations hitherto published. This quantity can be calculated considering its dependence on the strength function.

Calculation using the Hauser–Feshbach theory is also possible. (auth) (NSA of Japan)

49927 (JINR-P4-5125) INVESTIGATION OF PAIR CORRELATIONS OF THE SUPERCONDUCTING TYPE IN NUCLEI WITH A > 100 USING THE SAXON–WOODS POTENTIAL. Vdovin, A. I.; Komov, A. L.; Malov, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 18p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The dependence of the pair correlation constant on the atomic weight A, nuclear deformation and other values is investigated. The calculations were performed using the Saxon–Woods potential. It is shown that for the region 100 < A < 250 the constants G_N and G_Z can be represented as $G_{N,Z} \cdot A = g_{N,Z} + g_{N,Z} \cdot \Delta S \cdot A$, where ΔS is the increase of the nuclear surface due to deformation. (auth)

49928 (KFK-1189) HIGH RESOLUTION NEUTRON SCATTERING MEASUREMENTS AND THE ANALYSIS OF RESONANCE ANGULAR MOMENTUM AND PARITY. Nebe, J.; Kirouac, G. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Apr 1970. 10p. (CONF-700417-1). Dep. CFSTI (U. S. Sales Only).

From Joint Meeting of the German and Dutch Physical Societies, Eindhoven, Netherlands.

The assignment of neutron resonance spins and parities by direct examination of the differential scattering spectrum shape as a function of energy at a few scattering angles is discussed. The test case shown concerns the well known ^{12}C (n,n) scattering cross section in the energy range 2 to 6 MeV. Some of the highly structured ^{40}Ca scattering data are also shown. Detailed analysis of the calcium data is nearly completed and will be reported soon. (auth)

49929 (KFK-tr-313) EQUILIBRIUM DEFORMATION OF NUCLEI WITH NEUTRON EXCESS IN THE REGION A ~100. Arsen'ev, D. A.; Sobiczewski, A.; Solov'ev, V. G. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, W. Ger.), from report JINR–P4-4660. 18p. (In German). Dep. CFSTI (U. S. Sales Only).

Microscopic calculations of the equilibrium deformations for the ground state of even–even nuclei were made in the regions 28 < Z < 50, 50 < N < 82. The calculation method is described and the results are discussed. The following conclusions were made. The nuclei investigated were weaker with respect to β and γ deformation than the nuclei of the rare earth region. The deformation energy has a maximum of 4 MeV in comparison with 8 MeV for rare earth nuclei. These nuclei are apparently weaker with respect to the β deformation than the nuclei in the region 50 < Z, N < 82. The energy minimum of the nuclei is either at $\gamma = 60°$ or 0°, i.e., the axial symmetric form is found in equilibrium. The flat rotation ellipsoid is the equilibrium form for most of the nuclei. The sensitivity of the calculated results to a change of the parameter of the Nilsson potential and the pair interaction constants is to be expected. (tr-auth)

49930 (KFK-tr-320) INFLUENCE OF CHARGE DISTRIBUTION ON BETA DECAY. Vinduska, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, W. Ger.), from report UJV–1022/64. 9p. (In German). Dep. CFSTI (U. S. Sales Only).

The effect of the nuclear charge distribution on the beta decay was investigated. The nucleus with diffuse surface and its effect on the electron wave functions were discussed. The results of the calculations show that the difference between the electron functions in nuclei with diffuse surface and nuclei in which this effect was not considered was 10 to 15%. (tr-auth)

49931 (RLO-1388-578) ISOBARIC ANALOGUE RESONANCES IN PROTON ELASTIC AND INELASTIC SCATTERING. Bund, G. W.; Blair, J. S. (Washington Univ., Seattle). [1969]. 50p. Dep. CFSTI.

A model for proton elastic and inelastic scattering at isobaric analogue resonances in the one level approximation is presented. The basic assumptions made are that the coupling of the open channels to compound nuclear states with isobaric spin $T_0 - \frac{1}{2}$ is simulated by a phenomenological complex potential acting in the entrance and exit channels and that internal mixing of the isobaric analogue state with complicated compound nuclear states is small. The fractional parentage expansions characteristic of (d, p) stripping reactions on the parent states are explicitly introduced. The elastic and inelastic partial widths and the total width for the analogue of the ground state of ^{208}Pb are studied for different optical potentials and partial agreement with experiment is obtained. (auth)

49932 (RT/FI–(69)44) FISPRO II: A FORTRAN IV CODE FOR FAST NEUTRON RADIATIVE CAPTURE CALCULATIONS. Benzi, V.; Panini, G. C.; Reffo, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 15 Oct 1969. 28p. Dep. CFSTI (U. S. Sales Only).

The physical models and the programme FORTRAN IV written for the radiative capture cross-section calculations on the Hauser and Feshbach theory bases, are described in this report. Direct and collective capture and (n,2γ) process are also taken into account by means of simplified models. (auth)

49933 (RT/FI–(69)55) I. PERTURBATION THEORY WITH REGULAR POTENTIALS, HARD CORE POTENTIALS, AND BOUNDARY CONDITION MODEL INTERACTION IN THE NUCLEAR BOUND-STATE PROBLEM. Natoli, C.; Palumbo, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 13 May 1970. 13p. Dep. CFSTI (U. S. Sales Only).

It is shown that the eigenvalues of a system of particles bound by the interaction described by the boundary condition model do not depend on the interaction inside the core while the eigenfunctions are indeterminate. These properties of exact solutions often are not exhibited by the approximate ones, because of the inadequate mathematics involved. As an example the core volume contribution to the G matrix is considered. (auth)

49934 (UCRL-18861) COEFFICIENTS OF FRACTIONAL PARENTAGE FOR n → n-2 FOR LIKE NUCLEONS. Ross-Bonney, A. A. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 18p. Dep. CFSTI.

Numerical values and useful recursion relations are given for n → n-2 coefficients of fractional parentage in the case of like nucleons in j–j coupling. The maximum value of j for which calculations are included is $j = \frac{9}{2}$. (auth)

49935 (UCSD–10-P-11-105) 1. ISOTOPE-SHIFT OF NUCLEAR CHARGE DISTRIBUTIONS. 2. STATISTICAL THEORY OF DEFORMED NUCLEI. 3. VALIDITY OF THE STRUTINSKY SHELL CORRECTION THEORY. Lin, Wing-fai (California Univ., San Diego). 1970. 90p. Dep. CFSTI.

Thesis.

In the first chapter, the energy-density formalism is applied to the study of the isotope shift of nuclear charge distributions. It allows one to determine the part of the shift due to a statistical change in the proton densities. The study is improved by a shell-model calculation based on the Thomas–Fermi potential. The charge distributions are in relatively good agreement with experiment. However, the present model cannot reproduce the part of the shift due to non-monotonic changes in charge distributions. These non-monotonic effects are of a more complicated origin; they are of the same order of magnitude as the statistical shifts. In the case of the pair of ^{48}Ca–^{40}Ca the results are consistent with shifts calculated in self-consistent (Hartree–Fock) methods. In the second chapter, the changes in binding energy of $_{114}X^{298}$ under deformation into prolate spheroidal shapes were calculated using the statistical theory of nuclei. The density is restricted only by the requirement that each equidense surface is a spheroid. It is found that the energy is minimized when the density has an approximately uniform surface thickness around the nucleus. To first order the change in binding energy is given well by the liquid-drop model but at large deformation the statistical theory predicts less drop in energy and consequently a slightly more stable nucleus. In the third chapter, realistic shell-model potentials are used to test Strutinsky's method. It is found that the results are strongly dependent on the shell-smearing parameter as well as the order of the curvature correction for smearing. No unambiguous values can be obtained for the shell correction, even with the effect of the continuum properly included. As a result, the Strutinsky theory should be regarded only as a reasonable recipe to be used in combination with Nilsson potentials. (auth)

49936 SEARCH FOR THE COMMON SYMMETRY OF PAIRING + QUADRUPOLE FORCES IN NUCLEAR THEORY. Pomorski, K.; Szpikowski, S. (Curie-Sklodowska Univ., Lublin). Acta Phys. Pol.; B1: 3-12(1970).

Pairing forces connected with the $\mathfrak{D}_2$ group and quadrupole forces with the SU_3 group were taken together to generate the common symmetry group. It is proved that the resulting group is the symplectic group in (N + 1)(N + 2) dimension, where N is the major shell number. The special case of Sp(6) for N = 1 is discussed in detail. (auth)

49937 GENERALIZED SENIORITY AND BROKEN-PAIR COUPLING SCHEME. Lorazo, B. (Univ., Laval, Quebec). Nucl. Phys.; A153: 255-76(1970).

The ground state wave function of the 2n identical particles system being described by a superposition of n identical $J^\pi = 0^+$ coupled pairs 1_+, the total configuration space of the shell

model is divided into subspaces according to the number of pairs I_+ they contain. This provides a coupling scheme, the broken-pair one, formally identical to the quasiparticle coupling scheme, but conserving the particle number. Numerical study of the broken-pair structure of the eigenstates of some interactions, such as pairing, surface delta and more realistic ones, is performed using projections on and diagonalization within restricted space. An attempt to determine the connection between the broken-pair coupling-scheme and the quasi-spin properties of the residual interactions is made. (auth)

49938 TWO-PION EXCHANGE CONTRIBUTION TO THE NUCLEON–NUCLEON FORCE AND AN EFFECTIVE σ-MESON. Riska, D. O. (NORDITA, Copenhagen); Brown, G. E. Contract AT(30-11)-4032. Nucl. Phys.; A153: 8-16(1970).

The longest range contribution to the nucleon–nucleon force, due to two-pion exchange with a virtual N^*_{33} isobar in the intermediate states, is calculated. The terms with only nucleons in the intermediate states is added to this, and the potentials which would result from $\sigma(J^P = 0^+, T = 0)$ and $\sigma'(J^P = 0^+, T = 1)$ meson exchange, such as are commonly employed in one-boson exchange models for the force, are roughly fitted to the total two-pion exchange potential. (auth)

49939 EFFECT OF NEUTRON–PROTON PAIRING CORRELATIONS ON THE TRANSFER OF A NEUTRON–PROTON PAIR. Froebrich, Peter (Technische Hochschule, Munich). Z. Phys.; 236: 153-65(1970).

A theory of neutron–proton pairing interaction is developed considering both $J = 0$, $T = 1$, and $J \neq 0$, $T = 0$ correlations. The model of a single j-shell is investigated explicitly for $N = Z$ nuclei. Instead of solving the full HFB(Hartree Fock Bogoliubov) problem a variational method is used for determining the ground state energy and wavefunction. The model shows that the best solutions contain either only $T = 0$ or only $T = 1$ correlations. A solution mixing $T = 0$ and $T = 1$ is energetically worse. It is estimated in PWBA(Plane Wave Born Approximation) that for ground state transitions at light nuclei in the transfer of a neutron–proton pair the cross section is enhanced up to a factor 3 by pairing correlations compared with shell model calculations. (auth)

49940 MICROSCOPIC DESCRIPTION OF THE (γ,pn) REACTION. Weise, Wolfram (Univ., Erlangen, Ger.); Huber, Max G.; Danos, Michael. Z. Phys.; 236: 176-91(1970).

The quasideuteron process has been investigated for photon energies 40 MeV < E_γ < 160 MeV on the basis of a shell model picture modified by short range nucleon–nucleon correlations. It turns out that the cross section for the (γ,pn) reaction depends sensitively on the details of the correlation function, i.e., on the exchange of high momenta between otherwise independently moving nucleons. The final-state interaction has been consistently taken care of by using optical model wave functions for the outgoing nucleons. The results of the calculations for ^{16}O indicate that precise measurements of the (γ,pn) cross section do contain information on the properties of the nuclear wave functions for small internucleonic distances. (auth)

49941 FEW-PARTICLE CORRELATIONS IN NUCLEI. Eichler, Joerg (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 347-61 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

Correlations within groups of particles that are either coupled spatially or in angular momentum and isospin are discussed for the cases of three and four particles. The random phase approximation, quasiparticle-vibration coupling for three-body correlations, and generalized RPA theory for four-body correlations are discussed. (M.C.G.)

49942 TRANSIENT FIELDS ON RECOIL NUCLEI FOLLOWING COULOMB EXCITATION. Borchers, R. R. (Univ. of Wisconsin, Madison); Heestand, G. M.; Kugel, H. W.; Kalish, Rafael. pp 415-18 of Nuclear Reactions Induced by Heavy Ions. /Bock, R. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany. See CONF-690707.

The time dependence of the transient field and the magnitude of the field as a function of recoil velocity were investigated for Coulomb excitation and recoil implantation into ferromagnetic foils. The magnitude of the transient field was determined for elements from Fe to Pt. The results indicate that the transient field can be understood as a result of stopping ions in a ferromagnetic material. (M.C.G.)

49943 THREE-PARTICLE CORRELATIONS IN NUCLEAR MATTER. Fiset, E. O. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 2: 85-92(Jul 1970).

The Green's-function theories of nuclear matter have been extended to include three-particle correlations, with the result that one particular two-particle Green's-function theory, namely the λ_{10} theory of Puff, Reiner, and Wilets and of Foster, is found to have the very desirable property that it contains all two-particle correlations. A case is built for expending some effort to calculate the nonperturbative λ_{10} theory using realistic forces, in the hope of obtaining a value for the binding energy of nuclear matter close to the semiempirical value. Three-particle corrections to the "semirealistic" λ_{10} calculation of Foster are found to be a few tenths of an MeV, in good agreement with Bethe's results. (auth)

49944 ELASTIC SCATTERING AND THE K-MATRIX. I. EXPANSION OF THE K-MATRIX. Humblet, J. (Univ., Liege. California Inst. of Tech., Pasadena). Nucl. Phys.; A151: 225-42 (1970).

The K-matrix is expanded in terms of its poles in the complex-energy plane. The expansion contains no energy-dependent background term and the residues and resonance energies are independent of the channel radius. Any few-level approximation of this expansion provides a unitary parametrization of the collision matrix, in contrast to the few-level approximations deduced from the pole expansion of the collision matrix itself. Here, only the elastic scattering by a potential of finite range is considered, but a subsequent paper will introduce a similar expansion in the parametrization of the collision matrix for nuclear reactions proper. (auth)

49945 SIMPLE TRIPLET EVEN POTENTIALS. Peltola, E. I. (Univ. of Helsinki). Soc. Sci. Fenn., Comment. Phys.-Math.; 36: No. 5, 71-86(1969).

Triplet even potentials of the form $V(r) = V_C + V_T S_{12}$, where the outer part ($r \geq r_1$) of V_C and V_T is described by the one-pion-exchange potential and the inner part ($r_0 \leq r < r_1$) by square wells, are considered. The parameters of the potentials are fitted by using the deuteron ground state. Potentials with different r_0- and r_1-values are reported. Within the potential model used the deuteron D-state probability p_D is shown to lie between rather narrow limits which depend slightly on the hard core radius r_0. The best hard and soft core potentials are tested by calculating triplet even phase shifts and the binding energies of nuclear matter. For the former a good fit is obtained up to medium energies. (auth) (Finland)

49946 CONDITIONS FOR THE WEAK ENERGY DEPENDENCY OF EFFECTIVE INTERACTIONS. Bolterauer, Hannes (Justus Liebig-Univ., Giessen, Ger.). Z. Phys.; 235: 474-84 (1970).

The possibilities for the existence of effective interactions depending weakly on the energy in a given interval are discussed. These interactions may be used in computing matrix elements of the Green operator in a model space. To show that the interval in which the model is valid may principally be chosen at random, effective interactions with poles at the eigenvalues of the operator $H + \lambda V^1$ are introduced, and the necessary properties of V^1 are considered. The operator V^1 determines the model space, and therefore the matrix elements of the Green operator which can be computed within the model. (auth)

49947 TEST OF FACTORIZATION METHODS IN COUPLED CHANNEL REACTION THEORY. Nguyen Van Giai; Marty, C. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A150: 593-608(1970).

Factorization methods used in shell-model approaches to nuclear reactions provide a good starting point for perturbative treatments of direct coupling. General algebraic equations are given for zero and higher orders. Problems of convergence of the Born series are tested with a soluble model. It is shown that the zero-order approximation is quite good. First- and second-order corrections are calculated and exhibit a rapid convergence. The influence of parameters entering in factorization formulae is discussed. (auth)

49948 TRINUCLEON BINDING ENERGIES CALCULATED WITH RANK SIX SEPARABLE POTENTIALS. Brady, T. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Lett.; 32B: 85-8 (8 Jun 1970).

A number of separable potentials which include both attraction and repulsion in all partial waves and which provide good fits to the nucleon–nucleon phase parameters are used in calculations of the trinucleon binding energy. (auth)

49949 ANALYSIS OF PARTICLE-GAMMA ANGULAR CORRELATIONS AND DISTRIBUTIONS. Taras, P. (Univ., Montreal). Nucl. Instrum. Methods; 85: 313-23(1970).

Angular distribution curves for a large number of spin sequences are presented. These can be used in the analysis of gamma-ray angular distributions following particle capture reactions and in the analysis of method II of Litherland and Ferguson when m = $\pm 1/2$. Values of the mixing ratio, for which gamma-ray angular distributions are isotropic, are also given. In addition, the effect of the finite size of the particle counter in particle-gamma correlations is shown to become less important with increasing spin of the initial state in a gamma-ray transition. (auth)

49950 APPLICATION OF THE BOGOLYUBOV VARIATIONAL PRINCIPLE IN NUCLEAR THEORY. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 365-72 of Problemy Teoreticheskoi Fiziki. /Blokhintsev, D. I. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

It is shown that the variational principle, quasiaverage, and other mathematical methods developed by N. N. Bogolubov are widely used in nuclear theory. Pairing superconductive correlations of nucleons and collective vibrational states in atomic nuclei are treated by these methods. (auth)

49951 TREATMENT OF NUCLEAR REACTIONS BY KOHN'S VARIATIONAL PRINCIPLE. Heiss, P.; Hackenbroich, H. H. (Univ., Cologne). Z. Phys.; 235: 422-30(1970).

The extension of the Kohn-Hulthen variational principle to the multi-channel reaction problem is discussed. It is shown that this method leads to a unitary S-matrix. As an application of the method a four channel calculation for the $^3/_2^+$ state of ^{5}Li is presented. (auth)

49952 LOW-ENERGY THEOREM FOR EXCHANGE AXIAL-VECTOR CURRENTS. Ohtsubo, H.; Fujita, J. I.; Takeda, G. (Tokyo Univ.). Phys. Lett.; 32B: 82-4(8 Jun 1970).

A low-energy theorem is given for the two-body exchange current of axial-vector type. The exchange current is divided into two parts, the one directly related to the nuclear forces and the remainder, and the numerical results for the former are shown to be in good agreement with experiments for the beta decay of triton. (auth)

49953 NUCLEAR POLARIZATION IN MUONIC ATOMS OF DEFORMED NUCLEI. Chen, Min-yi (Columbia Univ., New York). Phys. Rev., C; 1: 1176-83(Apr 1970).

The analysis of muonic x-ray spectra in deformed nuclei was carried out in the past by diagonalizing the electric quadrupole interaction between the spin doublets ($2p_{\frac{1}{2}}$, $2p_{\frac{3}{2}}$), ($3d_{\frac{3}{2}}$, $3d_{\frac{5}{2}}$) and the lowest rotational band of the nucleus. With the present experimental accuracy, this procedure is no longer adequate. To take into account the muonic and nuclear states not included in the diagonalization, we renormalize the electric quadrupole interaction by virtual excitations into those states. The renormalization correction is found to amount to a few percent of the quadrupole matrix elements. This explains the systematic tendency for the intrinsic quadrupole moments obtained from the traditional analysis to be a few percent larger than the values deduced from Coulomb excitation experiments. The inclusion of the renormalization corrections is found to have a very significant effect on the parameters of the charge distribution and the intensity ratios of the hyperfine multiplets. (auth)

49954 NUCLEAR POLARIZATION IN MUONIC ATOMS OF SPHERICAL NUCLEI. Chen, Min-yi (Columbia Univ., New York). Phys. Rev., C; 1: 1167-75(Apr 1970).

The nuclear polarization effect in muonic atoms is calculated for ^{208}Pb and ^{40}Ca. The nuclear intermediate states of ^{208}Pb are collective particle-hole states calculated from realistic nucleon-nucleon forces. The total effect is an increase of binding of 6.0 ± 0.6 keV for the 1s level, 1.9 ± 0.2 keV for the 2p level, and 1.2 ± 0.2 keV for the 2s level. The uncertainties of the calculation are set at the relatively small values given above for the following reasons: The muonic intermediate states are treated exactly with the reference-spectrum method; the energies of nuclear intermediate states of $l > 2$ turn out to be small compared with muonic intermediate state energies; the nuclear dipole states have been well studied experimentally and theoretically; and the nuclear monopole polarization calculated from the particle-hole states has been checked with a Thomas-Fermi theory which gives the observed surface thickness and the surface energy. Similar calculations for ^{40}Ca give the correction to the 1s level as 0.2 keV. Henley and Cooper's closure approximation, which leads to a large correction of 58 keV to the ^{208}Pb 1s level, is repeated with two of the following improvements: The intermediate muonic states in the continuum are treated properly, and the two-nucleon cross terms in the ground-state nucleus are included. The correction then comes down to 6 keV. (auth)

49955 ALPHA-DEUTERON MODEL OF ^{6}Li. Fantoni, S. (Scuola Normale Superiore, Pisa, Italy); Rosati, S. Nucl. Phys.; A151: 317-22(1970).

An α-deuteron model of ^{6}Li has been studied allowing for the distortion of the deuteron wave function: the results indicate that a careful consideration of the distortion is necessary. Spurious components which violate the Pauli principle have been projected out of the trial wave function and the binding energy has been evaluated again. The adequacy of the model is shown to be satisfactory. (auth)

49956 GENERALIZED SU_3 ROTONS IN THE ELLIOTT MODEL. Mikhailov, I. N.; Nadjakov, E. G. (Joint Inst. for Nuclear Research, Dubna, USSR, Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 23: 663-6(1970).

The Elliott model is used to check a previously formulated theory of nuclear rotation. It is shown that all essential features of the theory may be left unchanged. A possible generalization of the Elliott model is discussed which may account for the coupling between rotation and intrinsic excitations. Multiplets of broken SU(3) symmetry and transition operators in the Elliott model are considered. (J.F.P.)

49957 EFFECTS OF THE D-STATE OF THE DEUTERON IN THE WBP MODEL FOR (d,p) REACTIONS. Pearson, C. A. (Univ. of Alabama, Birmingham); Rickel, D.; Zissermann, D. Nucl. Phys.; A148: 273-85(1970).

The effect of the D-state of the deuteron on polarization, vector analyzing power, and differential cross sections for (d,p) reactions is discussed within the framework of the weakly bound projectile model. It is shown that D-state corrections are comparable to the uncertainties due to ambiguities in optical potentials. For a quantitative comparison of the theory with experiment it is necessary to calculate the D-state contribution. (auth)

49958 HIGHER-ORDER TERMS AND THE APPARENT NON-CONVERGENCE OF THE PERTURBATION EXPANSION FOR THE EFFECTIVE INTERACTION IN FINITE NUCLEI. Barrett, Bruce R. (Univ. of Pittsburgh); Kirson, Michael W. Nucl. Phys.; A148: 145-80(1970).

All significant terms through third order in the reaction matrix G, which contribute to the perturbation series for the $J = 0$, $T = 1$ effective interaction between two valence nucleons in the mass-18 nuclei and also a few selected fourth-order terms were calculated. It is shown that the perturbation series does not converge order-by-order to third order in G and that certain large third-order terms tend to cancel the second-order contribution. An intuitive physical picture of the process giving rise to this effect and to analogous effects in related calculations of the effective charge is given. This picture suggests a rearrangement of the perturbation series into physically significant groups of diagrams, so that each group converges order-by-order in G. However, one must then find some way to sum all these groups of diagrams. It was concluded that simple perturbation theory is not a reliable method for calculating the effective two-nucleon interaction in mass-18 nuclei, when currently standard calculational techniques are used, and that the success of first- plus second-order perturbation theory in fitting experimental spectra for these nuclei is unexplained. (auth)

49959 REACTION-MATRIX CALCULATION OF THE Λ-PARTICLE BINDING IN NUCLEAR MATTER. Rote, D. M. (Univ. of Illinois, Chicago); Bodmer, A. R. Nucl. Phys.; A148: 97-134 (1970).

The two principal procedures for obtaining the phenomenological Λ well depth D from the experimental separation energies B_Λ are discussed. A value $D \approx 30 \pm 2$ MeV, with an upper limit $D \lesssim 35$ MeV, is consistent with results obtained from both procedures. A reaction-matrix calculation of D is made for central ΛN potentials. This is exact in the g-matrix approximation, which gives the term proportional to the density ρ in an expansion in powers of ρ. To calculate the g-matrix the reference-spectrum method is used in the Kallio-Day form. The free kinetic energies are used for the unoccupied states. The difference between the single-particle energies of the bound and excited states of the Λ involves a gap that is identified with the well depth. This leads to a self-consistency condition for the determination of D. The nucleon-spectrum parameters are taken from the calculations of Sprung et al. The angle-average approximation for the exclusion-principle operator, appropriate to a Λ in nuclear matter, is examined and found to be excellent. For hard-core potentials, a perturbation expansion in the strength of the attractive tail is in general inadequate and, especially for potentials of short range, it is necessary to obtain the g-matrix exactly for the complete potentials.

For given low-energy scattering parameters, the presence of a sizable hard core very substantially reduces D. The p-state contribution to D can be quite large, especially for the phenomenological potentials with hard cores and with larger intrinsic ranges. Thus for Herndon and Tang's potentials which fit the binding energies of the A = 3 and 4 hypernuclei as well as the Λp scattering data and which have rather hard cores, one can get close to the phenomenological value of D by assuming zero p-state interaction. With some p-state interaction—about half of that for the s-state—reasonable suppression of the ΛN–ΣN coupling in nuclear matter can give agreement with the phenomenological depth. The well depth is found to depend fairly linearly on ρ over a large range and the Λ effective mass can be as small as 0.65 M_Λ. (auth)

49960 LEVEL DENSITY FOR SOME PARTIALLY RANDOM HAMILTONIANS. Gervois, A. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nuovo Cim.; 69B: 181-208 (11 Oct 1970).

The level density of a random Hamiltonian H such that the total configuration space can be split into irreducible subspaces using for example invariance properties is studied. The level density is supposed to be known for each individual subspace and the matrix elements connecting the various subspaces are treated as random variables. A similar problem arises when the Hamiltonian may be written in the form $H_0 + V$, where H_0 has a known level density and V, the residual interaction, is a random matrix. In both cases, one starts from the relation of the level density to the average of the resolvent. The latter expanded in powers of the interaction, and by scaling considerations one gets the dominant contributions. The final result is easily obtained when the matrix elements of the residual interaction are statistically independent. Some simple algebraic examples are given; in particular, the "semi-circle" law is recovered, and some generalizations are indicated. (auth)

49961 CALCULATIONS OF LEVEL DENSITIES BASED UPON REALISTIC SHELL MODELS IN THE ^{208}Pb REGION. Moretto, L. G.; Stella, R.; Crespi, V. Caramella (Univ., Pavia, Italy). Energ. Nucl. (Milan); 17: 436-43(Jul 1970).

Level densities and spin cutoff parameters are calculated for nuclei in the ^{208}Pb region, starting from realistic sets of single-particle levels, taken from shell model results. The numerical calculation of such level densities is performed by means of a statistical approach, with the only approximation being use of the saddle point technique in the computation of the Darwin–Fowler integrals. This method is almost as accurate as the combinatorial approach, yet it requires a much simpler numerical calculation. The calculated level densities and spin cutoff parameters are discussed in terms of closeness of nuclei to the doubly magic nucleus ^{208}Pb (82 protons and 126 neutrons) and of degeneracy of the levels close to the Fermi surface. A lack of symmetry in the shell effect is found between nuclei with equal numbers of particles or holes removed from the doubly closed shell. A realistic shell model implies a rather complex dependence of level densities and spin cutoff parameters on the excitation energy, behavior not reproduced by the Bethe level density expression. The work confirms earlier predictions by less realistic models by Gilbert and Rosenzweig. (R.W.R.)

49962 STABILITY CONDITIONS AND OTHER INEQUALITIES FOR THE TWO-COMPONENT FERMI LIQUID. Czerwonko, J. (Technical Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys.; 18: 97-102(1970).

The stability conditions for the two-component Fermi system are exhibited and proved. Isotopic invariance of the effective interaction between quasiparticles is not assumed, and the finite nature of the system considered is neglected. (R.W.R.)

49963 PERTURBATION TREATMENT OF LIKE NUCLEONS IN A LARGE SINGLE SHELL. Nomura, M. (Tokyo Univ.). Lett. Nuovo Cim.; 3: 117-20(22 Jan 1970).

The schematic model of like nucleons in a large single shell is used to investigate a many-body system. The perturbation method is used to find energies and effective charges of the states approximately expressed by a seniority smaller than 3. (R.W.R.)

49964 REGION OF FORMATION OF INTERNAL CONVERSION COEFFICIENTS ON HIGH SHELLS OF THE ATOM. Band, I. M.; sliiv, L. A.; Trzhaskovskaya, M. B. (Ioffe Inst. of Technical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 11: 201-4 (20 Mar 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 306-8 (20 Mar 1970).

The radius at which internal conversion coefficients (ICC) are formed is determined by studying the ratio of the ICC value at a given radius to the asymptotic value. The following results are found: the value of the ICC on all the shells of the atom, including the valence shell, is formed in the internal layers of the atoms; measurement of the ICC on high atomic shells, as well as on the internal shells, can be used to determine the spins and parities of the nuclear levels; the ICC on high shells of the atom should change little when changing the number of electrons on other shells and change appreciably when the total number of electrons changes in that shell from which the conversion takes place; measurement of the ICC can be used to determine the density of the electrons at zero. (R.W.R.)

49965 EVEN–ODD-STAGGERING IN γ-BANDS. Gneuss, G. (Univ., Frankfurt am Main); Greiner, W.; Mosel, U. Phys. Lett.; 32B: 161-4(22 Jun 1970).

In numerous γ-bands of even-even nuclei the odd-spin-members show systematic deviations from the I(I + 1)-rule. This "even-odd-staggering" is investigated theoretically by means of a collective model which treats rotations and vibrations in a uniform manner. In addition some aspects of anharmonicities in the kinetic energy are discussed. (auth)

49966 EXACT S-MATRIX FOR NON-DEGENERATE THRESHOLDS. Zimanyi, J.; Bondorf, J. P. (Univ. of Copenhagen). Phys. Lett.; 32B: 159-60(22 Jun 1970).

A simple exact expression based on unitarity is given for the energy dependence of an S-matrix element in terms of the S-matrix elements of the last open channel. The expression is applied to threshold phenomena. (auth)

49967 DIFFRACTIONAL SCATTERING AT LOW AND HIGH ENERGIES. Hadjimichael, E. (Fairfield Univ., Conn.). Phys. Lett.; 32B: 154-8(22 Jun 1970).

A diffractional model for elastic scattering of strongly absorbed particles is applied in the case of intermediate energy scattering of deuterons, tritons, alpha particles and heavy ions and high energy π^-p scattering. Unambiguous parameters of the model are determined by means of which an absorption parameter $r_\alpha = 1.398$ fm for nucleus-nucleus scattering, an interaction radius, R-0.581 fm, for π^-p scattering, and qualitative features of nuclear surface thickness are determined. (auth)

49968 HARTREE–FOCK CALCULATIONS WITH SKYRME'S INTERACTION. Vautherin, D.; Brink, D. M. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett.; 32B: 149-53(22 Jun 1970).

Hartree–Fock calculations have been made for closed shell nuclei using a form of density dependent nucleon-nucleon interaction suggested by Skyrme. The results are very good for binding-energies, densities and energies of single particle levels near the Fermi level. Calculations have been made in one superheavy nucleus. (auth)

49969 EFFECT OF THE PAULI PRINCIPLE ON THE REPRESENTATION OF NUCLEON PAIR OPERATORS BY MEANS OF BOSONS. Li, S. Y. (Univ. of Pennsylvania, Philadelphia); Dreizler, R. M.; Klein, A. Contract AF48(638)-1545. Phys. Lett.; 32B: 169-72(22 Jun 1970).

It is shown for a single j-shell how to determine boson expansions of fermion operators, which both satisfy the Pauli principle and converge as $j \to \infty$; for finite j natural limitations emerge concerning the degrees of freedom which can exhibit vibrational behavior. (auth)

49970 NUCLEAR FORCE IN THE INTERNAL REGION AND THE O.B.E. MODEL INCLUDING THE PARTICLE EXTENT. Ueda, Tamotsu (Osaka Univ.). Soryushiron Kenkyu; 40: D67-8 (Dec 1969). (In Japanese).

The OBE model for nuclear force was extended to the model which includes the internal structure of elementary particles. The extension was done by the use of the form factor which expresses the effect on the nuclear force resulting from the internal structure. The contribution to the form factor from the mesons $\pi, \rho, \omega, \eta(0^+, \pm = 0)$ and $\delta(0^+, I = 0)$ was explicitly calculated. The form factor has the form of $(\Lambda^2/(t + \Lambda^2))^2$. Its physical content, however, includes the contribution from other mesons and the higher contribution for the vertex part. The phase shift was given by the N/D method for the ^{1}So-state and by the Kantor method for other eleven states. The theoretical phase shift for the ^{1}So-state reproduced the experimental one up to about 3 GeV, and those for the other eleven states accorded with the experiment within 1.6 standard deviation. (auth) (Japan)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 48238.

49971 (ACNP-70502) INVESTIGATION OF PITTING CORROSION ON THE MALCOMIZED STAINLESS STEEL CONTROL ROD PUSH RODS IN THE LA CROSSE BOILING WATER REACTOR. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Jul 1970. Contract AT(11-1)-850. 61p. Dep. CFSTI.

Detailed visual and photographic examinations of the surface of malcomized push rod from CRD No. 27 are described. A static corrosion test on specimens of Type 304 stainless steel identical to the CRD push rods is reviewed. Results from the surveillance program and the corrosion test are presented. (D.C.C.)

49972 (AEEW-M-934) WIMS RESULTS FOR THE LONG-TERM IRRADIATION CHANGES IN THE CALDER HALL REACTORS. Phillips, C. J. (Atomic Energy Establishment, Winfrith (England)). Oct 1969. 11p. Dep. CFSTI (U. S. Sales Only).

The available measurements of the isotopic content of irradiated pennies of fuel from Calder Hall have been re-analysed with the WIMS-D code and the results are compared with previous ARGOSY-2A results. (auth) (UK)

49973 (AVR-34) POST-IRRADIATION EXAMINATION OF ATJ GRAPHITE FROM FIRST-CHARGE AVR FUEL ELEMENTS. Delle, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Translation of a German report. 14p. Dep. CFSTI.

Work performed under USAEC-BBK/AVR Reactor Exchange.

Samples are taken from spherical fuel elements of the first AVR charge for post irradiation examination. Results of the examination for ATJ graphite are presented. Radiation effects on apparent density, open porosity, specific electrical resistance, thermal conductivity, linear thermal expansion, and modulus of elasticity are measured. (D.C.C.)

49974 (CEA-N-1349) STUDY OF THE NEUTRON UPPER SHIELDING OF PHENIX. Brandicourt, G.; Culambourg, J.; Le Ralle, J. C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1969. 26p. (In French).

Calculations were made on four new types of shielding: ordinary graphite, dense graphite, stainless steel, and a graphite iron mixture. These shielding materials were then compared with a reference standard: graphite, iron and B_4C. The principal criteria considered were: the neutron attenuation (particularly for flux at the energy level of the exchangers), the damages of materials, the various costs, the activation of materials above the shielding, and the consequences of a burst slug. It was suggested that a new reference standard should be adopted (90 centimeters of dense graphite). The suitability of this standard with respect to the various trials envisaged awaits confirmation. 8 references. (auth) (France)

49975 (CONF-700401-, pp 93-112) FORT ST. VRAIN CONSTRUCTION PROGRESS. Wellhouser, H. N. (Gulf General Atomic, Inc., San Diego, Calif.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27-30, 1970, Oak Ridge, Tennessee.

The 330-Mw(e) Fort St. Vrain Nuclear Generating Station is being built by Gulf General Atomic Incorporated as prime contractor for the Public Service Company of Colorado as part of the USAEC Power Reactor Demonstration Program. Among the significant design features incorporated in the plant are the prestressed concrete reactor vessel, once-through modular steam generators with integral superheaters and reheaters, steamdriven axial-flow helium circulators, and hexagonal graphite fuel elements incorporating improved coated fuel particles. Construction of the plant featured the use of ground freezing to provide a cofferdam to keep ground water from the excavation and preplaced aggregate concrete for the bottom head of the prestressed concrete reactor vessel. As of March 31, 1970, construction is estimated to be over 62% complete and on schedule for a completion date of June 1971. (auth)

49976 EXPERIENCE ON THE MATERIALS USED IN NUCLEAR POWER PLANTS. Cuttica, G.; Gasparini, R.; Ioannilli, E. (Ente Nazionale per l'Energia Elettrica, Rome). Energ. Nucl. (Milan); 17: 469-80(Aug 1970). (In Italian).

The structural integrity of certain nuclear power plant components is essential both to safe operation and achievement of high capacity factors. A few aspects of special interest of the experience acquired by Enel in the operation of its nuclear power plants are described. The steel embrittlement under irradiation is recalled, and various instances of material degrading as a result of fatigue, oxidation, or corrosion phenomena are described. (auth)

49977 GRAPHITE SUPPORT OF THE BUGEY 1. Chevallier, R. Tech. Mod.; 61: 399-406(Nov 1969). (In French).

The graphite support grid is one of the essential structural components of a CO_2 cooled graphite moderated reactor. Reasons for choice of design and steps in its construction are discussed. (UKAEA Info. Bulletin)

49978 FUEL HANDLING SYSTEM AT BUGEY 1 POWER STATION: AUTOMATED CONTROL AND SUPERVISION. Binet, M.; Bonnard, M. Tech. Mod.; 61: 407-9(Nov 1969). (In French).

Automation of the principal mechanical handling system by digital computer is described. This ensures automatic working of the charge machine, controls fuel elements, tests equipment, and operates auxiliary circuits. (UKAEA Info. Bulletin)

49979 REACTOR TECHNOLOGY. VOLUME 13, NUMBER 3. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Washington, D. C.; Atomic Energy Commission (1970). 131p. GPO $0.75.

Separate abstracts are included for each of the 7 articles presented. Topics discussed include: Sodium-Cooled Reactors; Gas-Core Reactor Technology; Xenon-Induced Spatial Power Oscillations; Emergency Core Cooling Problem in LMFBR; and Intergranular Corrosion Cracking of Type 304 Stainless Steel in Water-Cooled Reactors. (D.C.C.)

For abstracts of individual papers see: 49980, 49998, 50079, 50089, 50129, 50200, and 50231.

49980 SODIUM-COOLED REACTORS: PHYSICS ASPECTS OF THE ENRICO FERMI FAST BREEDER REACTOR. Steele, Myrna L. (Atomic Energy Commission, Oak Ridge, Tenn.). Reactor Technol; 13: 191-213(1970).

The results of physics tests on Core A are summarized. The results should permit a generalized assessment of reactor characteristics and behavior, and a comparison with future core loadings. 9 references. (auth)

49981 PRESTRESSED CONCRETE REACTOR VESSEL. Buttemer, D. R.; Rockenhouser, W. (Gulf General Atomic Inc., San Diego, Calif.). Mech. Eng.; 92: No. 9, 34-8(Sep 1970).

General design characteristics for a prestressed concrete pressure vessel are presented. Design parameters of the Fort St. Vrain Power Reactor Unit 1 prestressed concrete pressure vessel are listed. (D.C.C.)

49982 SIMULATORS AND OPERATOR LICENSING. Kelly, Frank L.; Skowholt, Donald J.; Morris, Peter A. (Atomic Energy Commission, Washington, D. C.). Nucl. News; 12: No. 11, 56-9 (Nov 1969).

Information concerning the types of reactor operator licenses and the requirements for each type of license is presented. Procedures for obtaining and maintaining operator licenses are described. (D.C.C.)

Operation and Economics

49983 (AEC-tr-7179) GUNDREMMINGEN (KRB) NUCLEAR POWER PLANT. Annual Report, 1969. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). Translation of a German report. 53p. Dep. CFSTI.

Operations and maintenance requirements during 1969 are described. Coolant chemistry measurements during the period are presented. (D.C.C.)

49984 (DLCS-5000270) SHIPPINGPORT ATOMIC POWER STATION. Quarterly Operating Report, Second Quarter 1970. (Duquesne Light Co., Shippingport, Pa. Power Stations Dept.). Contract AT(11-1)-292. 23p. Dep. CFSTI.

Operations and maintenance requirements during April to June 1970 are described. Tests results and coolant chemistry conditions are presented. (D.C.C.)

49985 (DOCKET-1155-77) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, July 1970. (Dairyland

Power Cooperative, La Crosse, Wis.). 1 Oct 1970. Contract AT(11-1)-851. 27p. (DPC-851-13). Dep. CFSTI.

49986 (DOCKET-1155-78) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, May 1970. (Dairyland Power Cooperative, La Crosse, Wis.). 5 Oct 1970. Contract AT(11-1)-851. 43p. (DPC-851-11). Dep. CFSTI.

49987 (DOCKET-50029-131) YANKEE NUCLEAR POWER STATION. Operation Report No. 116, August 1970. (Yankee Atomic Electric Co., Westboro, Mass.). 21 Sep 1970. 9p. Dep. CFSTI.

49988 (DOCKET-50206-91) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, July 1970. (Southern California Edison Co., Los Angeles). Aug 1970. Contract AT(30-1)-3270. 5p. (NYO-3270-40). Dep. CFSTI.

49989 (DOCKET-50263-44) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Problems Associated with Standby Gas Treatment System. (Northern States Power Co., Minneapolis, Minn.). 21 Sep 1970. 3p. Dep. CFSTI.

49990 (DOCKET-50263-46) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Abnormal Occurrence Report No. 3. (Northern States Power Co., Minneapolis, Minn.). 29 Sep 1970. 6p. Dep. CFSTI.

On Sunday, September 20, 1970, breakers from the 1AR transformer and the No. 12 Diesel Generator failed to close to supply power to one of the essential 4 kV buses during a loss of power test. The problem was associated with the undervoltage relaying on the essential bus. Detailed description of the occurrence and recommendations are presented. (D.C.C.)

49991 (DOCKET-50263-47) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Abnormal Occurrence Report No. 4. (Northern States Power Co., Minneapolis, Minn.). 29 Sep 1970. 5p. Dep. CFSTI.

On September 21, 1970 a failure occurred in the Standby Gas Treatment System which resulted in the burning of a portion of a charcoal filter in the A circuit of the system. Detailed description of the occurrence and corrective actions are presented. (D.C.C.)

49992 (NP-18431) AGESTA NUCLEAR POWER AND HEATING STATION. Annual Report, January 1, 1968-December 31, 1968. Vogt, Jan (Swedish State Power Board, Stockholm). 20 Feb 1969. 57p. (In Swedish). Dep. CFSTI (U. S. Sales Only).

Operation and maintenance requirements for the Swedish Reactors (R-3) during 1968 are reviewed. Radiation testing programs are described. (D.C.C.)

49993 (TID-25535) MONTHLY REPORT ON GUNDREMMINGEN NUCLEAR POWER PLANT, JUNE 1970. (Kernkraftwerk RWE-Bayernwerk, G.m.b.H., Gundremmingen (West Germany)). 10 Jul 1970. 55p. (In German). Dep. CFSTI.

Operations and maintenance requirements during June 1970 are described. Coolant chemistry measurements are included. (D.C.C.)

49994 (TID-25536) MONTHLY REPORT ON GUNDREMMINGEN NUCLEAR POWER PLANT, JULY 1970. (Kernkraftwerk RWE-Bayernwerk, G.m.b.H., Gundremmingen (West Germany)). 12 Aug 1970. 54p. (In German). Dep. CFSTI.

Operations and maintenance requirements during July 1970 are described. Coolant chemistry measurements are included. (D.C.C.)

49995 (TID-25537) OPERATING HISTORY OF U. S. NUCLEAR POWER REACTORS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). 1969. 88p. Dep. CFSTI.

The information assembled highlights the operating history of U. S. nuclear power plants through December 31, 1969. Included are those nuclear reactor facilities which produce (or have produced) electricity, even if in token amounts, or which are part of a development program concerned with the generation of electricity through the use of a nuclear reactor as a heat source. The information presented is based on data furnished by facility operators and was prepared by the Division of Reactor Development and Technology of the U. S. Atomic Energy Commission. The charts are plotted in terms of cumulative thermal energy as a function of time. Since only those shutdowns of five days or more are shown, the charts do not give a detailed history of plant operation. They do, however, give an over view of the operating history of a wide variety of developmental and experimental nuclear power reactors. The data presented in the tables show the yearly gross generation of electricity for each U. S. nuclear plant and, for civilian power plants, information on reactor availability and plant capacity factor. (auth)

49996 (TID-25538) GARIGLIANO NUCLEAR POWER STATION OPERATION REPORT FOR THE 1st QUARTER OF 1970. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 31 Mar 1970. 19p. Dep. CFSTI.

Operations and maintenance requirements during January to March 1970 are described. Coolant chemistry measurements are included. (D.C.C.)

49997 INVESTMENT AND FUEL EXPENSES OF ATOMIC POWER PLANTS. Balogh, Erno (Power Plant Investment Enterprise, Budapest). Atomtech. Tajek.; 12: 241-9(Jul-Aug 1969). (In Hungarian).

The general trend of investment and fuel expenses since the startup of the first Soviet 5-MW power plant at Obnisk is reviewed. The total installed capacity throughout the world reached 100,000 MW by the end of 1968. The four basic power reactor types examined include the PWR, BWR, graphite-moderated, and heavy-water-moderated and cooled reactors. The technical characteristics and expense data collected from the literature are tabulated, stating that after 1972 a cost reduction of about 10% may be expected on the basis of operating experience and the anticipated technical development. The problem of plutonium credit is also taken into account in the calculation of the expenses. (TTT)

49998 SODIUM-COOLED REACTORS: CURRENT STATUS OF PLANT-SYSTEMS OPERATIONS. Steele, Myrna L. (Atomic Energy Commission, Oak Ridge, Tenn.). Reactor Technol; 13: 222-4(1970).

A review of operations for the EBR-2 and Fermi Fast Breeder Reactor is presented. 6 references. (D.C.C.)

49999 NUCLEAR ENERGY IN THE PRESENT AND IN THE FUTURE. Silvestri, M. (CISE, Milan). Energ. Nucl. (Milan); 17: 523-32(Sep 1970). (In Italian).

The worldwide development of nuclear power plants is reviewed. Predictions in nuclear power plant growth are presented. (auth)

Safety and Siting

Refer also to abstract 48556.

50000 (CONF-700810-50) CONSIDERATIONS FOR SITING NUCLEAR POWER PLANTS IN AREAS WITH HIGH POPULATION DENSITY IN THE FEDERAL REPUBLIC OF GERMANY. Wachsmann, F.; Schwibach, J. (Gesellschaft fuer Strahlenforschung, m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Strahlenschutz). [1970]. 16p. (SM-146/52). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The generation of steam by nuclear power plants close to the place of consumption has recently become economically attractive for the chemical industry. Moreover, plants for the purpose of supplying electricity and heat for residential areas are now being considered. In the Federal Republic of Germany, the sites now being selected for industrial nuclear plants by the chemical industry normally show a high population density, even in their direct vicinity. Whereas exposure of the workers and the nearby population from normal operation should not be prohibitive, the risk from accidental releases of radioactivity must be assessed taking into account the possibility of remedial action. Construction of nuclear power plants close to a large population means abolishing the existing site restrictions. Therefore, it is necessary to examine whether the risk for the population can be further reduced. For this reason, underground construction of nuclear power plants has been proposed. Also, the problems of emergency planning for densely populated areas must be solved. 13 references. (auth)

50001 (DOCKET-1154-2) BONUS NUCLEAR POWER PLANT. Decommissioning Final Report. (Puerto Rico Water Resources Authority, San Juan. United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). 1 Sep 1970. 299p. (WRA-B-70-500). Dep. CFSTI.

50002 (DOCKET-1155-79) LA CROSSE BOILING WATER REACTOR. Power Range Nuclear Instrumentation Calibration to 100 Percent Power. (Dairyland Power Cooperative, La Crosse, Wis.). 23 Sep 1970. 11p. (DPC-851-15). Dep. CFSTI.

50003 (DOCKET-50003-51) INDIAN POINT STATION, UNIT NO. 1. Repair of Thermal Sleeve and Primary Coolant Pipe. (Consolidated Edison Co. of New York, Inc., New York). 18 Sep 1970. 41p. Dep. CFSTI.

50004 (DOCKET-50003-52) INDIAN POINT [STATION], UNIT NO. 1. Metallurgical Examination of Thermal Sleeve. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Aug 1970. 86p. (BAW-393). Dep. CFSTI.

50005 (DOCKET-50003-53) INDIAN POINT STATION, UNIT NO. 1. Failure Mechanism Study of Four Inch Thermal Linear, Phase I. (Franklin Inst. Research Labs., Philadelphia, Pa.). 5 Jun 1970. 8p. Dep. CFSTI.

For Consolidated Edison Co. of New York, Inc., New York.

50006 (DOCKET-50003-54) INDIAN POINT STATION, UNIT NO. 1. Analysis of Thermal Environment and Thermal Fatigue Due to Temperature Transients in 4-in. Thermal Sleeve. (Franklin Inst. Research Labs., Philadelphia, Pa.). 11 Sep 1970. 25p. Dep. CFSTI.

For Consolidated Edison Co. of New York, Inc., New York.

50007 (DOCKET-50003-55) INDIAN POINT STATION, UNIT NO. 1. Microprobe and Fractographic Examination of Thermal Sleeve. (Battelle Memorial Inst., Columbus, Ohio). 26 Jun 1970. 19p. Dep. CFSTI.

50008 (DOCKET-50010-67) DRESDEN NUCLEAR POWER STATION, UNIT 1. License No. DPR-2; Supplement A to Proposed Change No. 17. (Commonwealth Edison Co., Chicago, Ill.). 17 Sep 1970. 91p. Dep. CFSTI.

Design parameters for the emergency core cooling system are presented. (D.C.C.)

50009 (DOCKET-50010-68) DRESDEN NUCLEAR POWER STATION, UNIT 1. Requested Information Relating to the Furnace Sensitized Stainless Steel Parts. (Commonwealth Edison Co., Chicago, Ill.). 21 Sep 1970. 26p. Dep. CFSTI.

50010 (DOCKET-50029-129) YANKEE NUCLEAR POWER STATION. Sensitized Stainless Steel Components Within the Reactor Coolant System. (Yankee Atomic Electric Co., Westboro, Mass.). 29 Sep 1970. 8p. Dep. CFSTI.

50011 (DOCKET-50029-130) YANKEE NUCLEAR POWER STATION. Comments on Uniform Monitoring Recording and Reporting Guide. (Yankee Atomic Electric Co., Westboro, Mass.). 29 Sep 1970. 2p. Dep. CFSTI.

50012 (DOCKET-50133-37) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Outage of July 17 Through August 7, 1970. (Pacific Gas and Electric Co., San Francisco, Calif.). Sep 1970. 42p. Dep. CFSTI.

50013 (DOCKET-50146-61) SAXTON REACTOR. Technical Specifications Change Request No. 39. (Saxton Nuclear Experimental Corp., Pa.). 28 Sep 1970. 4p. Dep. CFSTI.

A change in technical specifications concerning operation personnel is presented. The change provides two test engineers for the operation personnel instead of one test engineer. (D.C.C.)

50014 (DOCKET-50219-107) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Comments on Certain Activities at Oyster Creek Station, Functioning of Safety Committee, and Operating Organization. (Jersey Central Power and Light Co., Morristown, N. J.). 24 Sep 1970. 8p. Dep. CFSTI.

50015 (DOCKET-50219-108) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Nondestructive Testing Report for Selected Balance of Plant Systems Outside of Primary Containment: Progress and Results of Investigations. (Jersey Central Power and Light Co., Morristown, N. J.). 30 Sep 1970. 3p. Dep. CFSTI.

50016 (DOCKET-50219-109) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Technical Specifications Change Request No. 4. (Jersey Central Power and Light Co., Morristown, N. J.). 30 Sep 1970. 7p. Dep. CFSTI.

Deactivation procedures are proposed for the containment spray system and certain instrumentation channels so that required integrated leakage rate testing of the primary containment may be performed. (D.C.C.)

50017 (DOCKET-50237-75) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Changes to the Final Safety Analysis Report. (Commonwealth Edison Co., Chicago, Ill.). 23 Sep 1970. 13p. (DOCKET-50249-41). Dep. CFSTI.

Revised and additional information on the five electromatic relief valves is presented. (D.C.C.)

50018 (DOCKET-50244-48) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Location of the Accelerograph in Basement of the Intermediate Building. (Rochester Gas and Electric Corp., N. Y.). 16 Sep 1970. 4p. Dep. CFSTI.

50019 (DOCKET-50244-49) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Furnace-Sensitized Stainless Steel in Reactor Primary Coolant System: Requested Information. (Rochester Gas and Electric Corp., N. Y.). 6 Oct 1970. 20p. Dep. CFSTI.

50020 (DOCKET-50245-40) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Provisional Operating License No. DPR-21 with Technical Specifications. (Division of Reactor Licensing (AEC), Washington, D. C.). 7 Oct 1970. 191p. Dep. CFSTI.

50021 (DOCKET-50259-13) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Final Safety Analysis Report, Vol. 1. (Tennessee Valley Authority, Chattanooga. Office of Power). 25 Sep 1970. 575p. (DOCKET-50260-13; DOCKET-50296-12). Dep. CFSTI.

Information on Browns Ferry Power Reactor Units 1, 2, and 3 is presented under the following broad topics: Introduction and Summary; Site; Reactor; Reactor Coolant System; and Containment. (D.C.C.)

50022 (DOCKET-50259-14) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Final Safety Analysis Report, Vol. 2. (Tennessee Valley Authority, Chattanooga. Office of Power). 25 Sep 1970. 350p. (DOCKET-50260-14; DOCKET-50296-13). Dep. CFSTI.

Information on Browns Ferry Power Reactor Units 1, 2, and 3 is presented under the following broad topics: Core Standby Cooling Systems; and Control and Instrumentation. (D.C.C.)

50023 (DOCKET-50259-15) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Final Safety Analysis Report, Vol. 3. (Tennessee Valley Authority, Chattanooga. Office of Power). 25 Sep 1970. 505p. (DOCKET-50260-15; DOCKET-50296-14). Dep. CFSTI.

Information on Browns Ferry Power Reactor Units 1, 2, and 3 is presented under the following broad topics: Electrical Power Systems; Radioactive Waste Control Systems; Auxiliary Systems; Power Conversion System; and Structures and Shielding. (D.C.C.)

50024 (DOCKET-50259-16) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Final Safety Analysis Report, Vol. 4. (Tennessee Valley Authority, Chattanooga. Office of Power). 25 Sep 1970. 321p. (DOCKET-50260-16; DOCKET-50296-15). Dep. CFSTI.

Information on Browns Ferry Power Reactor Units 1, 2, and 3 is presented under the following broad topics: Conduct of Operations; Plant Safety Analysis; Conformance to AEC Proposed General Design Criteria; Structural Loading Criteria; Quality Assurance Plan; Site Gaseous Release Rate Limit Calculation; and Unit Sharing and Interactions. (D.C.C.)

50025 (DOCKET-50259-17) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Final Safety Analysis Report, Vol. 5. (Tennessee Valley Authority, Chattanooga. Office of Power). 25 Sep 1970. 140p. (DOCKET-50260-17; DOCKET-50296-16). Dep. CFSTI.

Information on Browns Ferry Power Reactor Units 1, 2, and 3 is presented under the following broad topics: Plant Nuclear Safety Operational Analysis; Core Thermal Design; and Identification and Resolution of Construction Permit Concerns. (D.C.C.)

50026 (DOCKET-50259-18) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 9. (Tennessee Valley Authority, Chattanooga. Office of Power). 23 Sep 1970. 44p. (DOCKET-50260-18; DOCKET-50296-17). Dep. CFSTI.

Financial data on the owners of the Browns Ferry Power Reactor Units 1, 2, and 3 are given in support of the application for operating license. The 1970 Annual Report for the Tennessee Valley Authority is included. (D.C.C.)

50027 (DOCKET-50259-19) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Environmental Statements, Proposed Procedure. (Tennessee Valley Authority, Chattanooga. Office of Power). 28 Sep 1970. 2p. (DOCKET-50260-19; DOCKET-50296-18; DOCKET-50327-19; DOCKET-50328-19). Dep. CFSTI.

50028 (DOCKET-50261-43) H. B. ROBINSON UNIT NO. 2. Operating Permit DPR-23, Request for an Amendment. (Carolina Power and Light Co., Raleigh, N. C.). 21 Sep 1970. 3p. Dep. CFSTI.

Request for revised possession limits on nuclear and byproduct source materials is presented. (D.C.C.)

50029 (DOCKET-50266-28) POINT BEACH NUCLEAR PLANT, UNIT 1. Safety Injection System Balanced. (Wisconsin Electric Power Co., Milwaukee). 5 Oct 1970. 2p. Dep. CFSTI.

50030 (DOCKET-50266-29) POINT BEACH NUCLEAR PLANT, UNIT 1. Facility Operating License DPR-24 with Technical Specifications. (Division of Reactor Licensing (AEC), Washington, D. C.). 5 Oct 1970. 174p. Dep. CFSTI.

50031 (DOCKET-50282-24) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Acceptance of Probable Maximum Flood Stage Computation. (Geological Survey, Washington, D. C.). 29 Sep 1970. 11p. (DOCKET-50306-24). Dep. CFSTI.

50032 (DOCKET-50289-26) THREE MILE ISLAND NUCLEAR STATION, UNIT 1 AND UNIT 2. Environmental Report: Operating License Stage. (Metropolitan Edison Co., Reading, Pa. Jersey Central Power and Light Co., Morristown, N. J.). 1 Oct 1970. 38p. (DOCKET-50320-17). Dep. CFSTI.

50033 (DOCKET-50293-28) PILGRIM NUCLEAR POWER STATION. List of Items not Conforming to Statements in Final Safety Analysis Report. (Division of Compliance (AEC), Washington, D. C.). 24 Sep 1970. 3p. Dep. CFSTI.

50034 (DOCKET-50293-29) PILGRIM NUCLEAR POWER STATION. Applicant's Environmental Report: Operating License Stage. (Boston Edison Co., Mass.). Sep 1970. 118p. Dep. CFSTI.

50035 (DOCKET-50293-30) PILGRIM NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 15 (Replaces Appendix D of Final Safety Analysis Report, Vol. 4). (Boston Edison Co., Mass.). 14 Sep 1970. 43p. Dep. CFSTI.

Revised and additional information concerning quality assurance procedures and standards is presented. (D.C.C.)

50036 (DOCKET-50309-23) MAINE YANKEE ATOMIC POWER STATION. Preliminary Safety Analysis Report, Amendment 15. (Maine Yankee Atomic Power Co., Wiscasset). 30 Sep 1970. 195p. Dep. CFSTI.

Financial data on the owners of the Maine Yankee Power Reactor are given in support of the application for construction permit and operating license. The 1969 Annual Reports for the Bangor Hydro-Electric Company and the Maine Public Service Company are included. (D.C.C.)

50037 (DOCKET-50313-24) ARKANSAS NUCLEAR ONE. Preliminary Safety Analysis Report, [Amendment 19], Suppl. 19. (Arkansas Power and Light Co., Little Rock). 30 Sep 1970. 10p. Dep. CFSTI.

Stress analysis for the concrete and reinforcing steel in the ring girder is presented. (D.C.C.)

50038 (DOCKET-50317-18) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Expanded On-Site Meteorological Study. (Baltimore Gas and Electric Co., Md.). 28 Sep 1970. 8p. (DOCKET-50318-18). Dep. CFSTI.

50039 (DOCKET-50329-23) MIDLAND PLANT, UNITS 1 AND 2. ACRS Report. (Division of Reactor Licensing (AEC), Washington, D. C.). 28 Sep 1970. 3p. (DOCKET-50330-22). Dep. CFSTI.

50040 (DOCKET-50341-20) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 11. (Detroit Edison Co., Mich.). 1 Oct 1970. 87p. Dep. CFSTI.

50041 (DOCKET-50344-14) TROJAN NUCLEAR PLANT. Preliminary Safety Analysis Report, Amendment 9. (Portland General Electric Co., Oreg.). 5 Oct 1970. 143p. Dep. CFSTI.

50042 (DOCKET-50352-7) LIMERICK GENERATING STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, [Amendment 1], Suppl. 1. (Philadelphia Electric Co., Pa.). 6 Oct 1970. 141p. (DOCKET-50353-7). Dep. CFSTI.

50043 (DOCKET-50363-8) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 2. (Jersey Central Power and Light Co., Morristown, N. J.). 25 Sep 1970. 144p. Dep. CFSTI.

50044 (DOCKET-50369-1) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 1. (Duke Power Co., Charlotte, N. C.). 18 Sep 1970. 450p. (DOCKET-50370-1). Dep. CFSTI.

Information on the McGuire Power Reactor Units 1 and 2 is presented under the following broad topics: Introduction and Summary; and Site and Environment. (D.C.C.)

50045 (DOCKET-50369-2) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 2. (Duke Power Co., Charlotte, N. C.). 18 Sep 1970. 312p. (DOCKET-50370-2). Dep. CFSTI.

Information on the McGuire Power Reactor Units 1 and 2 is presented under the following broad topics: Reactor; Reactor Coolant System; Structures; Engineered Safety Features; Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion System; and Waste Disposal Systems and Radiation Protection. (D.C.C.)

50046 (DOCKET-50369-3) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 3. (Duke Power Co., Charlotte, N. C.). 18 Sep 1970. 149p. (DOCKET-50370-3). Dep. CFSTI.

Information on the McGuire Power Reactor Units 1 and 2 is presented under the following broad topics: Conduct of Operations; Initial Tests and Operation; Safety Analysis; and Technical Specifications. (D.C.C.)

50047 (DOCKET-50369-4) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. License Application. (Duke Power Co., Charlotte, N. C.). 18 Sep 1970. 62p. (DOCKET-50370-4). Dep. CFSTI.

50048 (TID-25534) THERMAL EFFECTS STUDIES BY NUCLEAR POWER PLANT LICENSEES AND APPLICANTS, 1969. (Atomic Energy Commission, Washington, D. C.). 80p. Dep. CFSTI.

During 1969, the AEC Director of Regulation conducted a survey of AEC nuclear power plant licensees and applicants for licenses to obtain background data on research and studies they had undertaken or planned concerning effects of the discharge of heated condenser cooling water from their plants on aquatic environments. Responses were received from 43 licensees and applicants for nuclear plants at 54 sites located in 25 states. Eighty-one nuclear units were involved, consisting of 12 licensed for operation, 47 under construction, and 22 for which construction applications were pending with the Commission at the end of the year. Of the 54 sites, 17 are located either on seacoasts or on bays, sounds, gulfs or river estuaries near the ocean; 11 are located on large, natural inland lakes; 25 are located on rivers (several of which will utilize large man-made reservoirs); and 1 is a "dry" site from which discharges will not be made into an existing stream. The survey showed that a variety of measures are being taken by many utilities to minimize potential thermal effects of their plants and meet state water quality standards. In some instances, these involve radical modifications of original designs or plans for handling cooling water discharges and additional expenditures of several million dollars. Cooling tower systems are being built or planned for nuclear stations at 10 of the river sites involved. Other plans of utilities to minimize thermal effects include provision of such features as cooling ponds several thousand acres in size, subsurface discharge devices, multiport diffusers, deep water intakes, canals several miles long, and large capacity pumps to increase flow rate during the summer. Some 140 reports and documents concerning thermal effects studies were furnished by utilities in connection with the survey. Some reports indicated very extensive research and study programs extending over periods of several years. A number of programs are being conducted in concert with state and federal agencies. Individual utility expenditures committed to such study programs to date ranged up to $750,000 in some instances. Brief summaries of the information furnished by respondents, including some descriptive material that was previously available, are presented. Many of the reports and studies furnished with the responding letters are only referenced. Also, the summary sheets do not reflect all information received, particularly the details of studies still in the planning stage. (auth)

50049 SITING AND SAFETY OF CIVILIAN NUCLEAR POWER PLANTS. Barry, Peter J. CRC Crit. Rev. Environ. Contr.; 1: 193-220(Jun 1970).

Problems of controlling public health hazards from nuclear power plants are discussed in relation to the hazards from environmental pollution arising from industrial activity in general. The limitations of published papers for supplying information about the practices used to control safety of nuclear power plants are discussed. Other topics covered include a review of existing siting and safety practices for nuclear power reactors, probability approach, external factors affecting the safety of nuclear reactors, siting and safety requirements for routine operation, and reactor safety and public opinion. (auth)

50050 NUCLEAR SAFETY. VOLUME 11, NUMBER 5. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P.; Savolainen, A. W. (eds.). One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory, (Sep-Oct 1970). 71p. GPO $0.60.

Separate abstracts are presented for 8 of the 10 articles included. Nuclear safety information is presented under the following broad topics: General Safety Considerations; Control and Instrumentation; Plant Safety Features; Consequences of Effluent Release; Operating Experiences; and Current Events. (D.C.C.)

For abstracts of individual papers see: 48250, 50051–50055, 50158, and 50159.

50051 AEC GOES PUBLIC: A CASE HISTORY. Brown, Howard C. Jr. Nucl. Safety; 11: 365-9(Sep-Oct 1970).

In the spring of 1969, the U. S. Atomic Energy Commission decided to take the case for nuclear power directly to the public by way of the town hall and the village square, the university symposium, and the speaker circuit. A factual approach has been useful in countering misinformation and in allaying unfounded fears, but the initial outings also demonstrated that the facts do not always speak for themselves because they are highly complex and occasionally challenged by small segments of the scientific fraternity. It has been necessary to translate technical jargon into everyday language and to learn to compete with the showmanship of critics. The need for nuclear electric power is increasingly recognized, but no substantial abatement in public concern for the environment is in sight. Larger segments of the public recognize that the solution to the environmental problem is neither to turn the clock back nor the light switch off, and they are prepared to pay a little more for a clean environment. 5 references. (auth)

50052 WATER-REACTOR SAFETY PROGRAM PLAN. Bradburn, H. F.; Cooper, C. H.; Gilmore, C. E. Nucl. Safety; 11: 369-74(Sep-Oct 1970).

A comprehensive plan for use by the Division of Reactor Development and Technology in its administration of the water-reactor safety program and for informing the nuclear industry concerning the scope and objectives of the specific projects that comprise the program is described. The problems and information needs of reactor safety are analyzed. The views expressed, although not held universally throughout the industry, do generally represent a consensus determined from comments solicited from all major users of safety-related information. It is expected that the plan will be used to assure that the resources available to the safety program are applied where most needed. (auth)

50053 CRITERIA AND REQUIREMENTS FOR RDT PLANT PROTECTION SYSTEMS. Walker, C. S. Nucl. Safety; 11: 375-8(Sep-Oct 1970).

A set of general design criteria and requirements for reactor protection systems has been issued as a tentative standard for application to reactors and critical assemblies under the jurisdiction of the USAEC Division of Reactor Development and Technology. This standard, C 16-IT, includes within its scope all the active devices, such as instruments, actuators, and electric power supplies, necessary to prevent unacceptable release of radioactive materials or unacceptable plant damage. This standard applies to the overall behavior of the protection system, rather than to the design of individual equipment items. The major sections are Design Basis, Criteria and Requirements, and Quality Assurance. Emphasis is given the Design Basis section, which prescribes the interdisciplinary information and analyses for specifying the necessary protective functions, together with the system-reliability requirements. Criteria are then given for providing defenses against various kinds of failures and for accommodating the systems and procedures required to operate the plant normally. 7 references. (auth)

50054 SAFETY-RELATED OCCURRENCES REPORTED IN APRIL–MAY 1970. Casto, W. R. Nucl. Safety; 11: 401-3(Sep-Oct 1970).

50055 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. Nucl. Safety; 11: 419-31(Sep-Oct 1970).

50056 BRITISH NUCLEAR ENERGY SOCIETY SYMPOSIUM ON SAFETY AND SITING, LONDON, MARCH 28, 1969. London; Institution of Civil Engineers (1969). 138p. 100s. (CONF-690347).

Twelve papers were presented at this symposium. A separate abstract was prepared for each paper. (UK)

For abstracts of individual papers see: 50057–50066, 50170, and 50171.

50057 COMPARISON BETWEEN A RIGOROUS METHOD OF STATISTICAL FAULT ANALYSIS AND SOME SIMPLER METHODS. Joksimovic, V. (Atomic Power Constructions Ltd., Heston, Eng.). pp 13-21 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

The ultimate aim of statistical fault analysis is to assess the total environmental hazard due to all conceivable initiating events to which a nuclear power plant might be subject in its expected life. This results in a full safety evaluation comprising a spectrum of events with associated consequences and probabilities of occurrence. A general hazard evaluation method must comprise models describing both the statistical aspects of the fault occurrence and the consequences in terms of fission product release. In addition, due to the cumulative nature of risk assessment a model to perform summation of independent risks must be included. These requirements are satisfied by a compound model which appears to be a satisfactory executive tool for the implementation of the statistical fault analysis concept. Its application is described by giving an illustrative example; a comparison is offered with some other simpler methods proposed in the U. K. based upon treatment of the selected example. (auth) (UK)

50058 SITING POLICY AND SAFETY EVALUATION IN THE UNITED KINGDOM. Fryer, D. R. H. pp 31-6 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

U. K. policy recognizes that the radioactive content of an operating nuclear power reactor has the potential for serious harm to the public if such contents were released to the atmosphere. Furthermore it is accepted that there is no site within the U. K. which by its character will provide complete protection of the public against this potential hazard. Such protection as the remoteness of a site can provide is small compared with the safeguards that can be provided by adequate attention to the design, manufacture and operation of the plant. The intending operator must provide for the reactor system which he wishes to construct a comprehensive statement setting out the basis on which the safety of the installation will be argued. This must be supported by references to tests which have been done or will be done to demonstrate the contentions, by details of the standards and organization which will ensure that the design safety intentions are carried out in the field and by a statement setting out the principles on which normal operation of the plant will be controlled. The basic philosophy common to any type of reactor is that while efforts must always be applied towards minimizing the radioactive risk at all levels of release the safeguards against large releases will require exceptional attention. The early recognition of the potential hazards of a particular class of reactor provides a basis in the form of safety principles upon which the detailed design may be developed. (auth) (UK)

50059 SITING OF CEGB NUCLEAR POWER STATIONS. Adams, C. A.; Faux, F. (Central Electricity Generating Board, London). pp 37-43 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

Except in the case of Hartlepool, all the nuclear power station sites at present licensed to the C. E. G. B. were selected on the basis of the siting criteria proposed in 1955. These criteria required sites to be remote from large populations and technical considerations at the time favored coastal or estuarial areas. To ensure the best use of national resources, both in amenity and economic aspects, it was thus very desirable to examine the basis for the siting policy. Alternative proposals are described which resulted from these re-examinations. The policy which finally emerged and allowed the licensing of Hartlepool in 1968 is expressed primarily in qualitative terms. The probability approach to safety assessment provides a formal basis to which further siting principles can be related. A reference is made to some possible developments in this field. A principle based on the reduction of individual risk to some agreed level is advocated. This enables the safety assessment of a reactor to be linked to exclusion distance and to emergency actions, both in terms of distance and type. In addition, the method enables due regard to be paid to any special features of the installation which affect the dependence of individual risk on distance. Whether this basis or one of the many possible specifications of acceptable population risk is used, it is recommended that the requirements be stated in their most simple and fundamental form. Any derived standard concerned with acceptable

population numbers is likely at some time to be questioned. If the basic requirement is known the licensee bears the responsibility of showing that it is satisfied for the specific combination of site and plant for which he has obtained a license. (auth) (UK)

50060 PROBABILITY ANALYSIS APPLIED TO AN ADVANCED GAS COOLED REACTOR. Kirk, J.; Sell, J. E. pp 49-57 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

The application of a probability analysis to the safety assessment of an A. G. R. design is discussed. It is shown that the reliability of the reactor trip system must be very high if the currently proposed release/frequency criteria are to be satisfied. Ultimately, safety depends on the removal of heat from the core by the essential cooling systems. The degrees of redundancy which need to be built into such systems may be dictated by economic as well as safety considerations. The relevance of iodine release data, failure rates of mechanical plant and extent of plant maintenance is considered. (auth) (UK)

50061 APPLICATION OF PROBABILITY ANALYSIS TO HTGR. Heaton, J. F. (Nuclear Power Group Ltd., Knutsford, Eng.). pp 59-67 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

The main features relevant to the safety of the HTR are described and the behavior of the reactor under various fault conditions is discussed. The problem is indicated of performing a rigorous probability/consequence analysis on a reactor system before all the detail components have been fully specified, as for manufacture. Using a simplified approach with approximate probabilities and quantities, the principal accident sequences are reviewed in order to highlight the components which dominate the safety of the HTR. (auth) (UK)

50062 PROBABILITY ANALYSIS APPLIED TO SGHWR. Cartwright, H.; Holmes, J. A. G.; Poulter, D. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 69-77 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

An introductory survey of the salient features of the S.G.H.W.R. is given with special reference to those aspects which affect safety. Probability analysis is illustrated as an important tool to be used at the design stage. The consequences of a number of accidents or faults are considered. These are failure of external services and coolant circuit rupture. The ways in which possible alternative protective systems can be designed are considered and combined so as to limit the consequences of each fault. The reliability required from each unit in a system of engineered safeguards, including containment, in order to meet a specific safety criterion is discussed and some consideration is given to the design implications of achieving the required reliability. The accuracy to which reliability data for the more important plant is required is discussed. (auth) (UK)

50063 PROBABILITY ANALYSIS APPLIED TO LWR'S. PART 1. LOSS OF COOLANT ACCIDENTS. Lindackers, K.-H.; Stoebel, W. (Technischer Ueberwachungs-Verein Rheinland e.V., Cologne). pp 79-85 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

Until now it has been the practice in the Federal Republic of Germany to decide about site selection and engineering safeguards for nuclear power plants using the so-called maximum-credible-accident-concept (MCA-concept) as a guide line. In the future it will be necessary, instead of MCA-concept, to use a more quantitative approach because nuclear power plants must be constructed in more densely populated areas. With respect to Light Water Reactors loss of coolant accidents could lead to a relatively high release of fission products. The probability analysis is applied to loss of coolant accidents in the nuclear power plants of Würgassen (BWR) and Stade (PWR) which are now under construction. The influence of uncertainties in the main factors of this analysis (e. g. probability of failures in piping and containment) is discussed. (auth) (UK)

50064 PROBABILITY ANALYSIS APPLIED TO LWR'S. PART 2. APPLICATION TO THE EMERGENCY CORE COOLING SYSTEM. Kellermann, O. A.; Ullrich, W. pp 87-93 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

In the Federal Republic of Germany, the probability concept for safety analyses has not yet been applied to a complete light water reactor plant, due to the complexity of the systems involved. However, the method has been used in connection with systems, important for reactor safety, such as shut-down devices, emergency power supply, emergency core cooling, e. g. spray and flooding equipment etc. By dividing the whole plant into its important systems, their mechanism becomes clearer and more suitable for mathematical treatment. The low pressure emergency core cooling systems which are to be installed in the German 600 MWe nuclear power plant Würgassen are described. Several problems which have been attacked with the probability concept are discussed. First, the planned emergency core cooling system is described and its function explained. A reliability diagram is developed. The reduced network is given. The failure probability of the system's parts and of the whole emergency core cooling system is calculated. A tentative criterion, which may be used for quality judgment, is deduced. The problem of optimum maintenance intervals is dealt with. (auth) (UK)

50065 SUITABILITY OF GAS COOLED REACTORS FOR FULLY URBAN SITES. Cave, L.; Halliday, P. (Atomic Power Constructions Ltd., Heston, Eng.). pp 101-21 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

An assessment is made of the additional hazards to the public which could arise from a change to unrestricted sites as compared with the use of those affording some degree of isolation. This assessment is made for a wide range of hypothetical releases and leads to suggestions for changes in the criteria previously proposed for urban sites. The effect of these suggested changes in criteria upon the requirements to be met in reactor design is discussed in general terms and a re-evaluation is made of the various gas cooled reactor systems which are considered to be promising from an economic point of view. From this evaluation are assessed the changes in basic design features which would probably be necessary to make particular gas cooled systems suitable for unrestricted siting. (auth) (UK)

50066 PROGRESS TOWARDS THE IDENTIFICATION OF SAFETY REQUIREMENTS FOR ADVANCED REACTORS. Farmer, F. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 123-6 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

Any reactor in a populated community must have a low risk of releasing large quantities of fission products (10^4 curies I-131 and associated fission products), and the risk of even greater releases must be progressively reduced. Very high releases must essentially be linked with overheated or molten fuel when retention in the fuel lattice becomes ineffective. In addition, there are many uncertainties in the effectiveness of containment of a molten core and the ability to recool overheated cores becomes progressively more difficult with increase in core power and rating. Safety then lies in the prevention of fuel melting and this places even greater emphasis on the need for a good primary envelope, reliable means for shutdown and for the provision of auxiliary power. Whether the safety of future reactors can be engineered by following existing rules or past practices is considered. It is suggested that safety cannot be achieved by simple limits to parameters but requires renewed conviction and application of effort at all stages of development, design and construction. To achieve this requires the setting of a recognizable and common objective and the building up of experience and techniques for its achievement through a common corporate effort of all those concerned with reactor safety. (auth) (UK)

Steam and Power Conversion Systems

50067 COMPARATIVE CONSIDERATIONS OF DESIGN, MATERIALS, FABRICATION, AND TESTING OF NUCLEAR AND CONVENTIONAL POWER STATIONS. Kornbichler, H. Mitt. Ver. Grosskesselbetr.; 49: 375-84(Dec 1969). (In German).

For 600 MW(e) supply, steam generators and steam turbines are compared for nuclear and conventional stations. Requirements for steam generators, heat exchangers, pressure vessels and containment vessels, their fabrication and testing are given. (UKAEA Info. Bulletin)

Power Reactor Development

Refer also to abstracts 48130, 48138, 48206, 48207, 48796, 48820, 48872, 48873, 48888, and 49979.

50068 (CONF-700401) PROCEEDINGS OF THE GAS-COOLED REACTOR INFORMATION MEETING AT THE OAK RIDGE NATIONAL LABORATORY, APRIL 27–30, 1970, OAK RIDGE, TENNESSEE. (Oak Ridge National Lab., Tenn.). 937p. Dep. CFSTI $10.00.

Included are 40 papers on helium cooled high temperature reactor development, design concepts, and operating experience. Major emphasis is on the HTGR converter using graphite for the fuel structure and moderator. Gas cooled fast breeder reactor concepts using metallic-clad mixed oxide fuel pins are also discussed. Four papers were previously abstracted for Nuclear Science Abstracts and may be found in the Report Number Index as: EIR-181; GA-10012; GA-10065; and GA-10073. A separate abstract was prepared for each of the remaining 36 papers. (H.D.R.)

For abstracts of individual papers see: 49975, 50069–50075, 50100–50102, 50109–50120, 50139–50145, 50151–50154, 50172, and 50173.

50069 (CONF-700401–, pp 113-41) RELATIONSHIP OF THE HTR WITH EARLIER GAS-COOLED REACTORS. Furber, B. N.; Lowthian, C. S. (Nuclear Power Group Ltd., Knutsford (England)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

Many of the potential advantages of the HTR stem from the concept of particle fuel and the use of helium as a coolant. It is therefore significantly different in several aspects from the type of reactor already developed in the UK, but it is still basically a gas-cooled reactor system. The design and operating experience gained with the magnox reactors and the AGR, even if not immediately applicable, is directly relevant to determining the type of problems likely to be encountered and to finding the economic solutions. The design, experimental and constructional experience of early gas-cooled reactors which is applicable to the HTR is reviewed. 12 references. (auth)

50070 (CONF-700401–, pp 143-60) THE HIGH TEMPERATURE REACTOR DEVELOPMENT IN GERMANY (PRESENT SITUATION, PROGRAM, AND FUTURE ROLE). Kraemer, H. (Kernforschungsanlage, Juelich (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

A short report on the present status of HTR development in Germany is presented. The main problems which are still open are pointed out and the planned activities are mentioned. (auth)

50071 (CONF-700401–, pp 161-79) DESIGN, FEATURES, AND ENGINEERING STATUS OF THE THTR 300 MWe PROTOTYPE POWER STATION. Oehme, H.; Schoening, J. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The design of the THTR, its safety concept, and supporting development tests are described, as well as the status of engineering and construction arrangements. (auth)

50072 (CONF-700401–, pp 180-94) THE LAYOUT OF THE CORE AND FUEL ELEMENTS OF THE THTR. Ehlers, K.; Harder, H.; Schroeder, E. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The continuous loading and circulation of the fuel elements in pebble bed reactors results in a number of performance differences from reactors with prismatic fuel elements. Their influence on the layout of the core and fuel elements of the THTR is described. (auth)

50073 (CONF-700401–, pp 195-213) LARGE HTGR DESIGN STATUS. Goodjohn, A. J. (Gulf General Atomic, Inc., San Diego, Calif.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The design status of a nuclear steam supply system employing a high-temperature gas-cooled reactor and capable of producing sufficient high-quality steam to generate approximately 1100 MW(e) in a conventional reheat steam cycle is discussed. This design is based on the same technology and development work as the 330-MW(e) Fort St. Vrain Nuclear Generating Station. Several design improvements have been incorporated which either improve the safety or economics or facilitate the operation and maintenance of the plant. The reasons for some of these improvements are summarized. (auth)

50074 (CONF-700401–, pp 214-30) CONCEPTUAL DESIGN FOR A 600 MW$_e$ NUCLEAR POWER PLANT WITH HIGH TEMPERATURE REACTOR AND HELIUM TURBINE. Hodzic, A.; Stuermer, W.; Baust, E.; Twardziok, W.; Marx, K. W. (Gutehoffnungshuette Sterkrade A. G., Oberhausen (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

In the Federal Republic of Germany a development program for a 600 MW(e) High Temperature Reactor Power Plant with closed gas turbine cycle has been initiated. The present state of the conceptual design studies is described. (auth)

50075 (CONF-700401–, pp 795-811) THE GCFR DEMONSTRATION PLANT DESIGN. Fortescue, P.; Thompson, W. I. (Gulf General Atomic, Inc., San Diego, Calif.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The progress of a 300-MW(e) gas-cooled fast breeder demonstration plant design is described. The currently proposed form of the plant is presented, together with the reasoning behind some of the more important features. The choice of operating conditions calls for fuel and cladding temperatures no higher than those proposed for LMFBR application. By introduction of design refinements discussed, this change has been effected without degradation of the original performance targets. In achieving this result, the very considerable importance of proper optimization of steam and boiler conditions has been most sharply evidenced. (auth)

50076 (NP–18365) IAEA INTERNATIONAL WORKING GROUP ON FAST REACTORS THIRD ANNUAL MEETING, CADARACHE, 18–20 MARCH 1970. (International Atomic Energy Agency, Vienna (Austria)). 120p. Dep. CFSTI (U. S. Sales Only).

The national development programs on fast reactors and fuels of each of the participants at the meeting are summarized. Countries and organizations represented include: France, Japan, U. K., USSR, West Germany, Italy, and ENEA. (H.D.R.)

50077 (ORNL-TM-2987) DEVELOPMENT OF FUEL- AND COOLANT-SALT CENTRIFUGAL PUMPS FOR THE MOLTEN-SALT REACTOR EXPERIMENT. Smith, P. G. (Oak Ridge National Lab., Tenn.). Oct 1970. Contract W-7405-eng-26. 50p. Dep. CFSTI.

The Molten-Salt Reactor Experiment (MSRE), a small nuclear power reactor that produced about 7 MW of heat while operating at approximately 1225°F and atmospheric pressure, requires a pump in each of two circulating molten-salt systems. A vertical centrifugal sump-type pump was developed for each system through water and molten-salt tests of prototype pumps at temperatures to 1400°F and hot shakedown operation of the actual reactor pumps before they were qualified for reactor service. The development experience with the pumps in the molten-salt pump test stand and the performance of the reactor pumps in the MSRE are discussed. The hydraulic performance of the pumps circulating molten salt corresponded closely with the performance obtained with water. The reactor pumps served well throughout the approximately 30,000-hr operating life of the MSRE, which spanned the period August 1964 to December 1969, during which the reactor produced 105,737 MWhr(t) of nuclear energy. A backup pump (Mark-2), which contains additional volume in the pump tank to accommodate thermally expanded salt, was also fabricated and tested for the MSRE. 15 references. (auth)

50078 THEORETICAL INVESTIGATION OF SOME MASS TRANSFER PROBLEMS WITH CHEMICAL REACTION. McGill, Ralph Norman. Raleigh, N. C.; North Carolina State Univ. (1969). 114p. University Microfilms Order No. 70-9254.

Thesis.

The presence of water vapor in the coolant stream of a high-temperature gas-cooled nuclear reactor with unclad fuel elements will give rise to the chemical reaction of water vapor and graphite reacting to form carbon-monoxide and hydrogen gas. The water vapor may be present in the coolant stream either as an impurity or as the result of an accident in the system. The first part of the present study is concerned with the analytical determination of the graphite loss from the fuel elements as a function of time and position resulting from the chemical reaction between water vapor and graphite. A flat plate geometry is chosen for the fuel elements, and a slug flow velocity profile and quasi-steady-state conditions are assumed for the coolant stream. The mathematical formulation of

the problem consists of two equations for the conservation of mass; one for the water vapor in the coolant stream and the other for the water vapor in the graphite. These equations are coupled through a coupling condition at the interface between the graphite and the coolant stream. The integral transform technique is used to solve the resulting equations, and one-dimensional, time-dependent analytical relations are given to predict the following four basic quantities: (1) the rate of loss of graphite as a function of time and position, (2) the time integrated graphite loss as a function of position, (3) the space averaged rate of graphite loss, and (4) the space averaged and time integrated graphite loss. The second part of the present study is concerned with the determination of the rate of deposition of fission products on the walls of a large containment vessel which contains a steam-air mixture as its atmosphere. The fission products may enter the containment vessel together with the steam as a result of an accident in the system. A flat plate geometry is chosen to describe the walls of the containment vessel. The mathematical formulation of the problem involves equations of conservation of mass for the steam, air, and fission products in the bulk gas mixture and the momentum equation. The Marker-and-Cell method of finite differences is chosen to solve the coupled partial differential equations numerically. The effects of concentration of steam vapor in the bulk gas mixture and the dimensionless decay constant on the deposition of fission products are investigated. The results are presented in the form of charts to illustrate the effects of various parameters on the deposition of fission products. (Diss. Abstr.)

50079 INTERGRANULAR CORROSION CRACKING OF TYPE 304 STAINLESS STEEL IN WATER-COOLED REACTORS. Cheng, C. F. (Argonne National Lab., Ill.). Reactor Technol; 13: 310-19(1970).

Nuclear pressure vessels, primary piping, core components and fuel-element cladding are subject to cyclic thermal and mechanical stresses due to the high pressure and temperature of the coolant or of the fuel. When 304 stainless steel is used as material for these parts, potential intergranular corrosion failures due to the combined action of corrosion and low cyclic stress or high static stress need critical evaluation. The performance of 304 stainless steel is reviewed with respect to: the instances of service failure other than chloride or caustic cracking in water-cooled reactors, the various corrosion studies on intergranular cracking, and the proposed mechanisms of intergranular corrosion cracking. 44 references. (auth)

50080 DEVELOPMENT OF A SYSTEM FOR COLLECTING AND ANALYSING SERVICE FAILURES. Marsh, W.; Ferguson, H. R. M. S. Nucl. Eng. Design; 13: 322-36(Aug 1970).

A computerized system for collecting and analyzing service failures of complex engineering systems is described which has been designed to provide management with detailed information, in order to reduce the costs of building and running a plant, and to enable accurate priorities to be given to all problem areas concerned with unreliability and breakdown. The analysis system will also provide information for future design purposes aimed at improving reliability and cutting production and running costs. The analysis system described is considered sufficiently flexible to meet foreseeable problems over the lives of the engineering complexes it was designed to serve, and the cost of running it amounts to approximately 0.005% of the capital cost of the equipment, whose performance it is analyzing. (auth)

50081 TIME-DEPENDENT METHODOLOGY FOR FAULT TREE EVALUATION. Vesely, W. E. (Idaho Nuclear Corp., Idaho Falls). Nucl. Eng. Design; 13: 337-60(Aug 1970).

A methodology is developed by which exact and detailed probabilistic information is obtained for any fault tree. The methodology, called "Kinetic Tree Theory," is believed to be a major advancement in the field of reliability and safety analysis and is expected to have far-reaching ramifications. The first assumption of Kinetic Tree Theory is that the primary failures, or components, of the fault tree are independent; one primary failure may occur at any number of places in the fault tree, but those primary failures which are unique are assumed independent. Interdependent primary failures can be handled by extension of the methods presented. The second and last assumption of Kinetic Tree Theory is that the mode failures (critical paths) of the fault tree are known. These are obtainable in a straightforward manner from the fault tree as is demonstrated. Fault trees of any structure and of any complexity are handled. General failure and repair distributions are handled; there is no limitation to these distributions as in other methodologies. Complete probabilistic information is first obtained for each primary failure of the fault tree, then for each mode failure (critical path), and finally for the top failure itself. The information is obtained as a function of time, and hence, with regard to reliability and safety; complete kinetic behavior is obtained. The expressions developed are in a simple form, and as is shown, application to yield numerical results is both efficient and straightforward—with an average computer time on the order of one minute required for a 500 primary failure fault tree (on an IBM 360/75 computer). (11 references.) (auth)

50082 COMPUTER PROGRAM FOR SYSTEM RELIABILITY ESTIMATION. Renk, K. D. (Univ., Berlin). Nucl. Eng. Design; 13: 361-4(Aug 1970).

A new system reliability computing program has been developed. The mathematical foundations are described. Some properties of the computing program are presented. (auth)

50083 NUCLEAR PROCESSES AND SPECIAL FEATURES OF NUCLEAR POWER PLANT CONSTRUCTION. Anan'ev, E. P.; Dobrinskaya, A. A. Sb. Tr., Mosk. Inzh.-Stroitel. Inst.; 56: 61-70(1968). (In Russian).

Various problems peculiar to the construction of nuclear power plants are discussed. The embrittlement of steel and the decrease in its plastic properties are pointed out. This change in physical properties may be due to the displacement of lattice atoms after collision with fast neutrons, or to the accumulation of hydrogen and helium in steel as a result of (n,p) or (n,α) reactions. The danger of failure because of embrittlement can be avoided by limiting the integral neutron dose to a value of 10^{21} to 10^{22} neutrons per cm^2 of steel. Another problem in water reactors is the breakdown of water under irradiation which accelerates the corrosion of steel because of the presence of excess oxygen. This higher corrosion must be taken into account. Greater reliability must be built into the reactor container in order to sustain the higher pressures of a boiling water reactor. The quality control measures used in assembling the Dresden reactor are outlined briefly. Containment in case of an accident is essential. The size of the outer containment shell is being steadily reduced in the USA. (TTT)

Kinetics and Dynamics

Refer also to abstracts 50211 and 50213.

50084 (AEEW-R-640) ANALYSIS OF ROD DROP AND PULSED SOURCE MEASUREMENTS OF REACTIVITY IN THE WINFRITH SGHWR. Brittain, I. (Atomic Energy Establishment, Winfrith (England)). May 1970. 49p. Dep. CFSTI (U. S. Sales Only). UK 7s.

Reactivity measurements by the rod-drop and pulsed source methods in the Winfrith Steam Generating Heavy Water Reactor are seriously affected by spatial harmonics. A method of calculation is described which enables the spatial harmonics to be calculated in non-uniform cores in two or three dimensions, and thus allows a much more rigorous analysis of the experimental results than the usual point model. The method is used to analyze all the rod-drop measurements made during commissioning of the Winfrith SGHWR, and to comment on the results of pulsed source measurements. The reactivity worths of banks of ten and twelve shutdown tubes deduced from rod-drop and pulsed source experiments are in satisfactory agreement with each other and also with AIMAZ calculated values. The ability to calculate higher spatial harmonics in non-uniform cores is thought to be new, and may have a wider application to reactor kinetics through the method of Modal Analysis. 7 references. (auth) (UK)

50085 (ANL-7541) DOCUMENTATION OF CRITICALITY DATA FOR EBR-II WITH A STAINLESS STEEL RADIAL REFLECTOR, EBR-II Project. Long, J. K.; Wallin, W. R. (Argonne National Lab., Ill.). Apr 1970. Contract W-31-109-eng-38. 63p. Dep. CFSTI.

During 1967 and the first half of 1968, the EBR-II reactor was operated with stainless steel subassemblies replacing its original depleted-uranium subassemblies in the inner two rows of the radial reflector. All data on the power coefficient of reactivity from the last run before the stainless steel substitution (run 24) up through and including the first runs for which depleted uranium was restored in this region (runs 29C and 29D) are presented. Core-loading diagrams for all core configurations during this period are included. A tabulation is also included of the results of studies of the power coefficient of reactivity at reduced flow. Reduced-flow studies were pursued extensively during the period to aid in distinguishing the fuel component from other components of the power coefficient of reactivity. A tabulation of the results of observations of slow periodic variations in power that occurred when the reactor was allowed to drift is presented. These slow variations only appeared when the stainless steel radial reflector was installed, and they disappeared when the depleted-uranium reflector was restored. (14 references) (auth)

50086 (CEA-R-4035) EXPERIMENTAL STUDY OF THE DOPPLER EFFECT OF URANIUM IN FAST AND THERMAL MULTIPLYING MEDIA. Guyader, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1970. 144p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Paris Univ., France.

Experiments on the Doppler effect were made in the critical MINERVE set up in which U samples heated by high frequency induction from a device located outside the reactor core were studied by oscillation techniques. In the spectrum of a natural U-fueled heavy water-moderated thermal reactor, the Doppler effect of ^{238}U ($S/M = 0.0725$ cm^2/g) was expressed by the variation of the effective capture integral and followed a $\sqrt{T}$ law from 300°K to 900°K. The β coefficient [$\beta = (0.53 \pm 0.04)10^{-2}$] was in good agreement with the values calculated. In the fast reactor spectra of the coupled fast-thermal critical assemblies ERMINE, measurements made over a wider temperature range (300 to 1100°K) showed, in particular, dilatation effects at the phase changes of metallic U. Measured temperature effects were analyzed and compared to results given by multigroup calculations. (auth) (France)

50087 (DP-1219) SRL EXPERIMENTS FOR THE JAPANESE POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION. Jarriel, J. L.; Pellarin, D. J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sep 1970. Contract AT(07-2)-1. 71p. Dep. CFSTI.

A set of experiments performed in the Subcritical Experiment (SE) and the Process Development Pile (PDP) at the Savannah River Laboratory (SRL) in support of the Japanese D_2O power reactor program are described. The results of these experiments will be used by the Japanese in evaluating calculational techniques for the design of a prototype, boiling H_2O-cooled, D_2O-moderated Advanced Thermal Reactor (ATR). The experiments were undertaken to determine control assembly worth, lattice bucklings, and detailed nuclear parameters. The measurements were made with D_2O, H_2O, and a H_2O-D_2O mixture in the coolant channels of the fuel assemblies, and at both 9- and 10-inch square lattice pitches, so that parameters for a variety of coolant conditions and lattice pitches of interest to the Japanese could be obtained by interpolation. The H_2O-D_2O mixture was used as a mockup of boiling H_2O coolant in the ATR. The fuel assemblies proposed for the ATR will consist of 28-rod clusters of UO_2 enriched to 1.5 wt.% ^{235}U and arranged on a 225-mm (8.86-inch) square lattice pitch. Because none of this fuel was available at the time the experiments were performed, a mockup of the Japanese fuel was used in the SE experiments. The mockup consisted of a 31-rod cluster containing natural UO_2. Rods of B_4C compacted to 70% theoretical density and arranged to form a control cylinder or tube were used as the neutron absorber. A complete control assembly consisted of three nested control tubes. Measurements of the worth of both the individual tubes and the complete assembly were made. Most of the experiments were performed in the SE. The relative worths of the individual tubes were also determined by substitution techniques in the PDP. 10 references. (auth)

50088 (TID-25528) DYNAMICS OF A FAST REACTOR WITH IN-CORE THERMIONIC CONVERTERS. Third Annual Report, September 1, 1968-August 31, 1969. Brehm, R. L.; Hetrick, D. L.; Ferg, D. A.; Guppy, J. G.; Kearns, K. D.; Schmidt, T. R.; Yee, S. (Arizona Univ., Tucson. Dept. of Nuclear Engineering). Jun 1970. Contract AT(04-3)-670. 126p. Dep. CFSTI.

The dynamics characteristics of fast in-core thermionic reactors are analyzed. Specific characteristics studied include: (1) effects of reactor coolant temperature changes on linear stability; (2) effects of nonlinear oscillations on stability of a two-region reactor; (3) oscillation boundaries in stable and unstable regions of a two-feedback reactor model; (4) stability analysis of reactor system models with time delay; (5) thermionic converter performance characteristics during startup; and (6) decoupling of multivariable control systems. 55 references. (H.D.R.)

50089 SODIUM-COOLED REACTORS: CURRENT STATUS OF EBR-II PHYSICS ASPECTS (RUNS 35 TO 40). Steele, Myrna L. (Atomic Energy Commission, Oak Ridge, Tenn.). Reactor Technol; 13: 214-21(1970).

50090 BREEDING RATIO FOR FAST REACTORS. Goldschmidt, P. (Belgonucleaire , Brussels). Nucl. Appl. Technol.; 9: 450-1(Oct 1970).

A theoretical definition of the breeding ratio for fast reactors is presented. Possible errors are analyzed. (D.C.C.)

50091 REPLY TO GOLDSCHMIDT. Ott, K. O. (Purdue Univ., Lafayette, Ind.). Nucl. Appl. Technol.; 9: 451-3(Oct 1970).

Revised statements concerning a theoretical definition of the breeding ratio for fast reactors are presented. (D.C.C)

50092 PROCEDURE FOR STUDYING THE STABILITY OF A BOILING-WATER REACTOR. Sankovskii, G. A.; Gritskov, V. I.; Poltavtseva, L. L.; Plyutinskii, V. I. This paper was summarized in At. Energ. (USSR); 25: 514(Dec 1968) as paper No. 245. (In Russian).

Using the example of the VK-50 reactor, a mathematical model is outlined which makes it possible to determine the region of stable operation of water-cooled, water-moderated, boiling-water reactors by a grapho-analytical method. The stability range of the VK-50 calculated in pressure vs. output coordinates is compared with an experimental curve. The structural layout of the reactor model breaks down arbitrarily into three parts: the reactor kinetics, fuel-element dynamics, and nonstationary flow of the steam-water mixture. (auth)

50093 OPTIMIZATION OF GAS-COOLED FAST REACTOR BLANKETS. Maeder, C. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng.; 42: 89-93(Oct 1970).

Economic radial and axial reactor blankets are determined by optimizing the gain earned from a blanket during the reactor life. The gain is composed of incomes from the sale of bred plutonium, of expenditures for fabrication and reprocessing of fuel elements, and of capital costs. Two management schemes are considered: the fixed blanket, in which a blanket fuel element remains at the same position until it is discharged from the reactor; the reshuffled blanket, in which blanket fuel elements are moved periodically in the radial inward direction. The method presented assumes that blanket fuel elements can be reloaded only at the same time as core elements, introduces radial blanket rows, and considers capital costs. Formulas for the calculation of the plutonium buildup and of the blanket gain are presented. The theory is applied to a 330-MW(e) gas-cooled fast reactor (GCFR). Radial blankets with one, two, and three rows of fuel elements are considered using both management schemes. Since the management of the axial blanket is identical with the core management, only the axial blanket thickness is optimized. (auth)

Control Systems

50094 (ANL/EBR-18) SURVEILLANCE AND EVALUATION OF THE EBR-II FLOW-MONITORING SYSTEM. EBR-II Project. Haroldsen, R. O.; Cushman, R. A.; Harrison, L. J.; Masters, S. M. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Apr 1970. Contract W-31-109-eng-38. 45p. Dep. CFSTI.

Because the many flow monitors active in the EBR-II shutdown circuit have been a continuing source of spurious trips, a study was begun to determine whether the flow-monitoring system could be simplified without compromising reactor safety. A simultaneous failure of power to both primary pumps was hypothesized, and the resulting temperature transient in the reactor was simulated by using the THTB code in a computation by IBM-360 computer. Certain penalties were imposed on the computation to ensure conservative results. The results of the THTB calculation indicate a temperature margin of 50°F (below the 1300°F level at which the eutectic between the fuel and cladding begins to form) for a case in which the reactor scram was delayed 4 sec after power failure to the pumps. More realistic assumptions about reactivity feedback effects and initial conditions would result in a wider temperature margin. Two conclusions that follow are: the reactor can be protected adequately from loss of coolant flow by redundant fixed-setpoint flow monitors; and the monitors that measure the rate of change of flow and the monitors on the pump auxiliary functions can be deleted safely from the reactor shutdown circuit. (7 references) (auth)

50095 NUCLEAR REACTOR REACTIVITY CONTROL METHOD. (to Societe Anglo-Belge Vulcain, Societe Anonyme). British Patent 1,206,728. 30 Sep 1970. Priority date 7 Sep 1967, Belgium.

REACTOR CONTROL SYSTEMS—design parameters of method for moderator temperature monitoring
REACTOR MODERATORS—temperature monitoring of, method for (D.C.C.)

Shielding

50096 (CEA-CONF-1566) CALCULATIONS OF THE ATTENUATION OF NEUTRONS BY COMPLEX GEOMETRIES. Nimal, Jean-Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 12p. (In French). (CONF-690963-3). Dep. CFSTI (U. S. Sales Only).

From National Meeting on Digital Analysis, Bordeaux, France.

Protection is necessary from the various radiations emitted from nuclear reactors. Protection from neutrons and γ rays is assured by shielding, which is often of complex geometry. Interactions and diffusion of neutrons and γ rays with materials obey complex laws, which are characterized by numerous numerical constants. The calculation of the intensity of the radiation at various points exterior to the shielding may be made by a computer simulation, which takes the various complexities of the individual case into account. Very few particles are not stopped by the protection. This last characteristic necessitates a bias of the simulation to minimize the computer time. (4 references) (auth) (France)

50097 (ORNL-TM-2896) LMFBR SHIELDING DEVELOPMENT PROGRAM. INTERIM REPORT. PRELIMINARY EVALUATION OF TECHNIQUES FOR PREDICTING THE SPECTRA OF NEUTRONS TRANSMITTED BY GRID PLATE SHIELDS. Clifford, C. E.; Mynatt, F. R.; Claiborne, H. C. (Oak Ridge National Lab., Tenn.). 31 Jul 1970. Contract W-7405-eng-26. 68p. Dep. CFSTI.

The status of the LMFBR shielding program in progress at Oak Ridge National Laboratory is described. The effort is mainly concerned with the evaluation and development of calculational techniques for predicting the fluence of neutrons that penetrate a sodium and stainless steel shield to reach the grid plate beneath the FFTF core. Experimental determinations of the spectra of neutrons transmitted through 12-in.- and 24-in.-thick shields of sodium, of iron, and iron pins plus sodium are compared with two-dimensional discrete ordinates calculations, and, in some cases, with Monte Carlo calculations of these spectra. Also presented are the results of a series of one-dimensional ANISN calculations made to evaluate the effect of material choice in an early FFTF configuration. On the basis of the studies completed to date, a number of conclusions are presented outlining the current situation regarding shielding design calculations of this nature. 12 references. (auth)

50098 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Burton, William Robert; Jackson, Alan (to United Kingdom Atomic Energy Authority). British Patent 1,199,322. 22 Jul 1970. Filed 2 May 1967.

A system is described in which shielding of the reactor core is effected by shield tanks through which liquid can circulate, the liquid in at least one of the tanks containing Np in solution or suspension. The advantage of using Np lies in its neutron absorbing properties to produce ^{238}Pu, which has uses as a power source; this in effect gives "cost-free" neutron absorption. The Np solution may be about 3% strength by weight in HNO_3, or an aqueous solution containing an excess of carbonate or sulphate ions to complex the Np and Pu, or an organic solvent solution such as dibutoxydiethyl ether or TBP. Alternatively the Np may be dispersed so as not to settle out and interfere with heat transfer requirements. The Pu may be recovered by solvent extraction or ion exchange, and the yield is dependent on the neutron flux and residence time in the tanks; the yield may be optimized by applying calculation. (UK)

50099 CALCULATION OF SHIELDING FOR A CIRCULATING FUEL LOOP. Rubanov, S. M.; Titov, V. I.; Shkorbatova, L. S. This paper was summarized in At. Energ. (USSR); 24: 375(Apr 1968) as paper No. 195. (In Russian).

Formulas are derived for calculating the specific source strength of delayed neutrons and γ-rays accompanying the decay of fission products in a circulating fuel loop. It was assumed that the variation of the total emitted energy with the time after fission for the decay of short- and long-lived fission products, E(t) in MeV/fission · sec, for times larger than 1.2 sec is described by the relations given by Goldstein. In view of the fact that the γ-radiation emitted in the internal from 0 to 1.2 sec does not exceed the error in determining the magnitude of the total yield of delayed γ-radiation, it was assumed that the relation which is correct for the range $1.2 - 10^3$ sec holds also from 0 to 1.2 sec. The formulas are presented. (auth)

Cooling Systems

50100 (CONF-700401–, pp 251-67) PROGRAM OF PLATE-OUT INVESTIGATIONS IN THE GAS TURBINE PROJECT. von der Decken, C. B. (Kernforschungsanlage, Juelich (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The program for investigation of the plate-out of fission products in the primary circuit of a HTR with closed cycle gas turbine is described. The principal theoretical and experimental aspects of the program are discussed and the SAPHIR in-pile loop experiment is briefly described. (H.D.R.)

50101 (CONF-700401–, pp 387-402) SHEAR FAILURES IN END SLABS OF PRESTRESSED CONCRETE PRESSURE VESSELS. Sozen, M. A.; Schnobrich, W. C.; Paul, S. L. (Illinois Univ., Urbana. Dept. of Civil Engineering).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The behavior of six small-scale PCRV's pressurized internally to failure is described. The primary object of the tests was to investigate the influence of penetrations on the shear strength of the end slab. Measured strains and calculated stresses in the end slab are discussed quantitatively to "establish" the mechanism of the observed failures. (auth)

50102 (CONF-700401–, pp 403-31) INVESTIGATIONS OF TIME-DEPENDENT BEHAVIOR OF PRESTRESSED CONCRETE PRESSURE VESSELS. Callahan, J. P.; Corum, J. M.; Whitman, G. D. (Oak Ridge National Lab., Tenn.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The effects of the thermal conditions imposed on a prestressed concrete reactor vessel (PCRV) present a major uncertainty in predicting long-term vessel behavior. A thermal cylinder model, which simulates a portion of the barrel section of a cylindrical vessel is being built and will be tested at Oak Ridge National Laboratory. The specimen will be subjected to mechanical and thermal loading histories that simulate, on a compressed time scale, the loading histories that an actual vessel might experience during the first few years of operation. Near the end of the test the specimen will be subjected to off-design hot spot conditions to obtain information on the capability of the structure to endure prolonged accidental over temperatures. The model will be instrumented to measure stress, strain, temperature, and moisture levels at selected locations. The basic materials investigations that are being carried out are discussed and some initial results and trends are presented. The thermal cylinder test is described and results from the preliminary design creep analysis of the test specimen are presented. (auth)

50103 (DP-Report-410) DECONTAMINATION OF STAINLESS STEEL LOOP PIPEWORK USING A PEROXIDE-INHIBITED SOLUTION OF OXALIC ACID. Project DRAGON. Pattison, J.; Davis, I. J. (Atomic Energy Research Establishment, Harwell (England)). Feb 1966. 14p. (AERE-R-5092). Dep. CFSTI (U. S. Sales Only).

An assessment of the ease with which parts of an H. T. R. coolant circuit could be decontaminated using a peroxide-inhibited oxalic acid solution has been made. A high degree of decontamination was achieved on pieces of pipe cut from Pluto Loop A which had been exposed to the helium coolant at temperatures between 300° and 500°C. No measure was made in these experiments of the amount of corrosion induced by the treatment. (auth)

50104 (ZJE-85) INSPECTION FOR TIGHTNESS OF NUCLEAR REACTOR COMPONENTS BY HIGH SENSITIVITY METHODS. Ungr, F. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 16p. Dep. CFSTI (U. S. Sales Only).

The vacuum method using helium for leak testing of the reactor outlet piping is evaluated. Theoretical preparation of the test, analysis of sensitivity, testing equipment, influence of measuring system and time on the sensitivity of measurement, and the procedure of the test are described. (auth)

50105 STEEL PRESSURE VESSELS. Phillips, C. A. G.; Warwick, R. G. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design; 13: 227-9(Aug 1970).

The annual potentially dangerous failure probability figure for nuclear primary circuit envelopes could be 1×10^{-2} but the sample is small and the technology is still developing. However, at present, it does not appear that an annual failure probability derived from relevant conventional vessel behaviour, such as 10^{-5} and 10^{-4} for catastrophic and potentially dangerous incidents respectively, will be pessimistic. (auth)

50106 CALCULATION OF THE NATURAL CIRCULATION IN THE CIRCUIT OF A WATER-COOLED WATER-MODERATED REACTOR. Selivanov, V. M.; Gorev, A. A.; Klimova, V. F.; Zdvizhkov, I. M. This paper was summarized in At. Energ. (USSR); 25: 136-7(Aug 1968) as paper No. 219. (In Russian).

The degree of reactor power taken as a result of the natural circulation of a single-phase heat carrier is primarily determined by the relative disposition of the active zone and the steam generator, as well as by the resistance of the circuit. In those systems in which the height of the circulation circuit is fairly small while the height of the active zone and the steam generator are comparable with it or of equal magnitude, the natural circulation in the circuit depends greatly on the temperature distribution in the latter. The problem of carrying out hydraulic and thermal calculations of the circuit for apparatus of a known geometry thus reduces to the solution of a system of differential equations representing the conservation of energy and momentum. When the heat and cooling sources are separated with respect to the height of the circuit, the natural circulation of a single-phase heat carrier in the circuit is described quite well by assuming a linear temperature distribution in the parts involving heat exchange. The approximate solution based on the linear model is compared with the exact solution of the equations of energy and momentum conservation, and the limits of applicability of the linear approximation are determined. A correction is introduced for the nonlinearity of the temperature distribution with respect to height, while still using the linear model. Allowance for this nonlinearity is made by reference to a geometrical circuit parameter, which in the linear approximation, is numerically equal to the distance (with respect to the height of the circuit) between the geometrical centers of the active zone and steam generator. (auth)

50107 PRESTRESSED CONCRETE PRESSURE VESSEL. Cruset, Jean-Louis; Launay, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,207,217. 30 Sep 1970. Priority date 3 Jul 1967, France.

PRESSURE VESSELS—design parameters of prestressed concrete
REACTORS—pressure vessels for, description of prestressed concrete (D.C.C.)

Fuels

Refer also to abstract 48149.

50108 (AAEC/TM–535) STUDY OF THE SHELL STRESS DISTRIBUTION IN A LOOSE KERNEL TYPE OF SPHERICAL FUEL ELEMENT FOR A PEBBLE BED REACTOR. Whatham, J. F.; Hawker, P. A. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr 1970. 34p. Dep. CFSTI (U. S. Sales Only).

The results are given of a study of the temperature and stress distributions on the surface of a spherical fuel element consisting of a beryllium oxide shell with a detached heat-generating kernel lying eccentrically (under gravity) on the shell wall and with carbon dioxide in the clearance space. Cooling of the outer surface of the shell was assumed to be uniform and the effects of variations in fuel element dimensions, material properties and cooling rate were examined. Subsequently the effects of a non-uniform distribution of surface heat transfer coefficient were investigated, the distribution having axial symmetry about the common center line of kernel and shell. Eccentricity of the kernel with respect to the shell substantially increases the maximum shell stress compared with that produced by a concentric kernel. However, the loose kernel fuel element compares favourably with one having the shell (or coat) bonded to the kernel. Nevertheless it is likely that in a pebble bed reactor the influence of other balls in contact on the variation of surface heat transfer coefficient would have an overriding effect on the shell stresses. (auth) (Australia)

50109 (CONF-700401–, pp 456–73) DEVELOPMENT OF BONDED COATED-PARTICLE BEDS FOR HTGR FUEL ELEMENTS. Scott, J. L.; Coobs, J. H.; Robbins, J. M.; Hewette II, D. M.; Conlin, J. A.; Senn, R. L. (Oak Ridge National Lab., Tenn.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

Fuel elements proposed for advanced HTGR's consist of hexagonal blocks of graphite with parallel fuel and coolant channels. The fuel channels are loaded with pyrolytic-carbon-coated particles of fuel and fertile materials. A method of bonding the coated particles into "fuel sticks" that will keep the fuel bed from falling apart during handling or during accidents that might damage the graphite core blocks was developed. The bonded fuel sticks also facilitate inspection of the fuel loading and enhance the transfer of heat from the fuel to the coolant. Several problems were overcome in developing a satisfactory binder. When a bed of particles was impregnated with phenolic resin binder and then heated to carbonize the resin, shrinkage broke coatings on some particles. Modified coatings that survived carbonization produced weak fuel sticks that disintegrated during irradiation to HTGR fast-neutron fluences. By using high concentrations of filler material in the binder (40 wt % Poco graphite powder in pitch or 29 wt % Poco graphite plus 29% Thermax carbon black in either pitch or resin), fuel sticks that remained intact throughout irradiation were produced. Only one damaged coating was found among 2000 coated particles examined in irradiated sticks prepared with these binders. (auth)

50110 (CONF-700401–, pp 474–93) DESIGN OF PRISMATIC HIGH TEMPERATURE REACTOR FUEL ELEMENTS. Smith, E. (Atomic Energy Establishment, Winfrith (England)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

Four designs of prismatic fuel pins suitable for use in HTR power reactors are described and their relative thermal performance in a fully and continuously gagged core with a gas outlet temperature of 900°C is compared. The stresses arising in fuel pins are described and the nature of the change in these stresses during irradiation is discussed. Attention is drawn to the importance of the material properties and their variation with irradiation dose and particularly to the need for defining the properties of the fuel matrix. (auth)

50111 (CONF-700401–, pp 494–517) THE DEVELOPMENT AND PERFORMANCE OF HTR CORE MATERIALS. Graham, L. W. (Atomic Energy Establishment, Winfrith (England)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The cores of prismatic High Temperature Gas Cooled Reactors are composed of structural graphite fuel blocks and tubes containing coated fuel particle assemblies. The design and performance of the coated particle is described in terms of the potential sources of fission product release together with the implications of the choice of coatings and of chemical and stressing effects occurring during service. The reasons for favouring the incorporation of the fuel particles into graphite matrix compacts are discussed and data presented on dimensional changes experienced during irradiation. For the structural graphite, the available commercial materials are adequate for the early launching of HTR power systems and the service conditions applying in these reactors offer scope for further improvements in the economy of power production. (17 references) (auth)

50112 (CONF-700401–, pp 518–46) CHOICE OF FUEL DESIGN FOR HOMOGENEOUS LOW ENRICHED HTR. Merrett, D. J.; Gaube, M. (Nuclear Power Group Ltd., Knutsford (England)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The specification of fuel particles for a commercial HTR design is considered. An 800 μm particle will be satisfactory and possess sufficient endurance to meet the economically desirable irradiations. These particles can be incorporated into compacts having sufficient strength, heavy metal density, and low breakage fractions to meet engineering and radiological requirements. The irradiation shrinkage behaviour is reasonably matched to that of fuel tube graphite. The incorporation of these compacts into various fuel element geometries is discussed and it is concluded that all the various configurations available meet limits which are either set by excessive fuel temperature, graphite stress or compact stress. Bearing these limits in mind, it is concluded that, economically and technically, the tubular interacting design of fuel pin is the preferred choice. As an alternative, the integral block design also appears to be economically attractive. (auth)

50113 (CONF-700401–, pp 547–85) FUEL DEVELOPMENT FOR A LOW ENRICHED HTR. Aerts, L.; Bairiot, H. (Societe Belge pour l'Industrie Nucleaire, Brussels); Skinner, R. A. (Nuclear Power Group Ltd., Knutsford (England)); Vangeel, J. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The development of a HTR fuel is outlined. The optimum porosity of the kernel requires further investigation, since there is a discrepancy between the design predictions and some irradiation results. Fabrication techniques have therefore been developed to cover the 85–95% TD range. The kernel properties within this range are compared. The coating layers follow the scheme proposed by the Dragon Project. Exemplative results are given on the variations of the dimensions and the properties within a batch and from batch to batch. Various approaches to the manufacture of fuel rods are presently being pursued. Some

results of fabrication trials and properties investigations are reported. The cases of tubular and teledial rods are outlined. An analysis of available corrosion data has been realized. The influence on the design of fuel pins is commented. Some unusual irradiation features are reported, as an illustration of the programme pursued is presented. (auth)

50114 (CONF-700401–, pp 586-97) HTR FUEL AND MATERIALS DEVELOPMENT IN GERMANY, PRESENT SITUATION AND PROGRAM. Liebmann, B.; Bugl, J.; Ehlers, K.; Hackstein, K. G. (Kernforschungsanlage, Juelich (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The German HTR program includes fuel and graphite development and irradiation testing. Pressed spherical fuel elements have been produced and loaded into the AVR since 1969 and will be used for THTR. The experience obtained with the AVR and the results of irradiation tests indicate that these elements will perform well in THTR and are well suited for larger power reactors. Parallel work on prismatic fuel elements has been started and will be increased in the coming years. Design data on the irradiation induced changes of the physical properties of commercially available and newly developed graphites for fuel elements and reflectors is provided by irradiation tests up to life-time doses. In addition a research and development program for new types of graphite for HTRs has been started. (auth)

50115 (CONF-700401–, pp 598-609) BEHAVIOR OF COATED PARTICLE FUEL IN DFR IRRADIATION EXPERIMENTS. Baier, J.; in der Schmitten, W.; Walger, P. (Kernforschungsanlage, Juelich (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The fast-neutron damage of several types of pyrocarbon coated particle layers was investigated by two irradiation experiments in the Dounreay Fast Reactor (DFR). The maximum fast dose accumulated in both experiments was 5.5×10^{21} n/cm^2 and 14.6×10^{21} n/cm^2 (E > 0.18 MeV) respectively; the temperature 1300°C. The results indicate that density and Bacon anisotropy factor (BAF) of pyrocarbon layers determine the irradiation behavior. It was found that a density of about 1.90 g/cm^3 and a BAF of about 1.03 alone do not guarantee the particles to remain intact after a dose of 14.6×10^{21} n/cm^2. It is assumed that another property not measured in the experiments is important at such high fast flux irradiations. (auth)

50116 (CONF-700401–, pp 610-18) EXPERIENCE WITH THE PRODUCTION OF AVR-FUEL ELEMENTS. Hackstein, K. G. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bein Hanau (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

More than 20,000 of the so called molded fuel elements were made for the AVR-Reactor. A critical examination of the most important data obtained during fabrication of kernels coated particles and spheres indicates that the production of large amounts of these fuel elements can be achieved without serious difficulties. Further development work has to be done with respect to the reproducibility of some properties. (auth)

50117 (CONF-700401–, pp 621-46) THORIUM-FUEL REPROCESSING RESEARCH AND DEVELOPMENT WORK AT THE KFA-JUELICH. Bohnenstingl, J.; Brodda, B. G.; Coenegracht, O.; (and others) (Kernforschungsanlage, Juelich (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

Work directed towards the development of suitable reprocessing methods for the graphite fuel elements is described. Two basically aqueous process-flow-sheets were established, on which all further efforts will be concentrated. The first-choice process consists of the following steps: (1) Burning of the fuel elements. (2) Dissolution of the residual oxides either in THOREX-reagent or in an acid-salt melt. (3) Isolation of protactinium by a sorption technique. (4) Thorium and uranium recovery and purification by TBP-extraction. (5) Waste treatment and solidification. This process will be demonstrated in the middle of the seventies in the "JUPITER" hot processing pilot plant. The capacity of this plant will be on the order of 2 kg of heavy metal per day. (11 references) (auth)

50118 (CONF-700401–, pp 833-53) DEVELOPMENT OF COATED PARTICLE FUEL FOR A GAS BREEDER REACTOR. Bairiot, H.; Thomson, J. M.; Aerts, L. (Societe Belge pour l'Industrie Nucleaire, Brussels).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The work carried out in order to define a coated particle fuel for a helium-cooled fast reactor is summarized. The first type envisaged is a modification of the coated particles developed for the HTR. Typically, the kernel is 800 microns mixed oxide, coated with PyC and SiC. On the basis of the available material characteristics, a mechanical design of such a particle has been carried out and the influence of the in-put data has been considered. This has led to a reference particle presently being developed. Data on the fuel obtained on a laboratory scale are included. As an alternative for the SiC coating, various metallic coatings have been considered. The development of these coatings is in the initial stage of demonstrating the feasibility; preliminary results are included. Two main draw-backs have appeared from these two programs and have led to the consideration of a larger size particle (10 mm diameter) coated with a metallurgically strong coating. Various concepts are presently being compared. (10 references) (auth)

50119 (CONF-700401–, pp 854-63) LATEST CALCULATIONS FOR A GCFR WITH A VANADIUM CLAD PIN CORE. Dalle Donne, M.; Eisemann, E.; Wirtz, K. (Kernforschungzentrum, Karlsruhe (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The results of the latest nuclear and thermal calculations performed for a GCFR with vanadium alloy (V–3Ti–1Si) clad pins and oxide and carbide fuel are presented. The helium temperature at reactor outlet is slightly above 700°C, in case of oxide fuel, which should give a reasonable plant efficiency with a direct cycle gas turbine and/or reduced capital costs. The core fissile inventory and the doubling time are 2800 and 1600 kg, and 18 and 8 years for oxide and carbide fuel, respectively. The problems connected with the choice of the cladding material (creep strength, high temperature embrittlement, swelling, compatibility with fuel and coolant) are discussed. (20 references) (auth)

50120 (CONF-700401–, pp 864-78) GAS-COOLED FAST BREEDER REACTOR FUEL-ELEMENT DEVELOPMENT. Fitts, R. B.; Long, E. L. Jr.; Lindgren, J. R.; Cuneo, D. R. (Oak Ridge National Lab., Tenn.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

A design study and irradiation test program is being carried out to provide a metal-clad ceramic fuel pin for the GCBR. The design study indicated that if the problems associated with the high overpressure on the fuel pins from the 85-atm helium coolant can be overcome, much of the fuel and cladding technology developed on the LMFBR program would be applicable to GCBR fuel pin design. Both sealed and manifold-vented fuel pin concepts were considered. The manifolded design has been chosen as the reference GCBR design due to its projected performance and economic potential. The thermal flux irradiation testing of sealed fuel pins culminated with a successful test of fuel-cladding-interacting-type pins. The (U, 12% Pu)O_2 fuel pins were clad with either Hastelloy X or Type 316 stainless steel and operated with 700°C cladding temperatures to 60,000 MWd/tonne burnup. No serious fuel-cladding mechanical or chemical interactions were observed in these pins. Data developed in earlier tests describing mechanical stability and fuel-cladding chemical interactions as a function of cladding temperature and coolant overpressure are also presented. (auth)

50121 (EUR-4406) DEVELOPMENT OF PROTOTYPE FUEL ELEMENTS FOR PRESSURIZED WATER POWER REACTORS. Final Report. Amato, I.; Frigerio, G.; Moncassoli, A. M.; Previti, G. (FIAT, Turin (Italy). Sezione Energia Nucleare). 11 Nov 1969. 110p. (In Italian). Dep. CFSTI (U. S. Sales Only). EUR Lit. 2,060.

The development of a fuel element with UO_2 pellets clad with Zircaloy-4 is described. The supporting frame is of stainless steel whereas the grids are made of Inconel. The fabrication of a prototype fuel element is described. The most interesting aspects are described of the nuclear, thermohydraulic and mechanical design of the fuel element together with the setting up of its fabrication technology. 7 references. (auth)

50122 (ORNL-TM-3081) POSTIRRADIATION EXAMINATION OF FUEL ELEMENT S-83 FROM CORE II OF THE ARMY SM-1 STATIONARY MEDIUM POWER REACTOR. Haynes, V. O.;

Richt, A. E. (Oak Ridge National Lab., Tenn.). Oct 1970. Contract W-7405-eng-26. 53p. Dep. CFSTI.

Stationary fuel element S-83 from Core II of the Army Stationary Medium-Power Reactor (SM-1) at Ft. Belvoir, Virginia was examined to determine if the high-pH coolant water used during its service produced any observable effects different from those noted in examination of similar SM-1 Core I fuel elements (neutral-pH coolant water). Detailed nondestructive examinations, followed by destructive examinations of several of the fuel plates, indicate that the postirradiation condition of this element was similar to that observed for SM type elements previously examined. The oxide surface film on the fuel plates from fuel element S-83 appeared to be less uniform than the film observed on other SM-type fuel elements. A pit found on one plate was given a detailed examination. Excluding the slight difference in the appearance of the oxide surface film, the examination of fuel element S-83 indicates little or no difference in the irradiation behavior of SM Type 1 fuel elements attributable to the change from operation in neutral-pH to high-pH coolant water and confirms that these elements perform satisfactorily to SM-1 operating requirements. 10 references. (auth)

50123 NUCLEAR SAFETY STUDY: FUEL BEHAVIOR. Johnson, R. L.; Johnson, S. O.; Freund, G. A. (Idaho Nuclear Corp., Idaho Falls). Nucl. News; 13: No. 8, 65-8(Aug 1970).

Studies on fuel failure thresholds and failure modes are presented. The Capsule Driver Core in the SPERT-4 facility is described. Testing programs with Zircaloy-2 clad UO_2 fuel rods are reviewed. (D.C.C.)

50124 EFFECTS OF CLADDING THICKNESS AND THERMAL CONDUCTIVITY ON HEAT TRANSFER FOR LAMINAR IN-LINE FLOW THROUGH ROD BUNDLES. Dwyer, O. E.; Berry, H. C. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 42: 69-80(Oct 1970).

The results of an analytical study are presented for the case of fully developed heat transfer to fluids in laminar, longitudinal flow through unbaffled rod bundles. The rods represent reactor fuel pins, which consist of ceramic cores encased in a metallic or alloy cladding. The study was based on the thermal boundary condition of uniform heat flux on the inner surface of the cladding. The three prime independent variables are rod spacing (P/D), relative cladding thickness $[(r_2-r_1)/r_2]$, and relative cladding conductivity (k_w/k_f). These have been varied over the ranges of 1.05 to 1.30, 0.025 to 0.300, and 0.10 to 4.00, respectively; and the following quantities have been determined as functions of the above variables: rod-average heat transfer coefficients, circumferential variation of outer-surface cladding temperature, same for the inner surface of the cladding, circumferential variation of local heat flux, and finally, circumferential variation of local heat transfer coefficients. It is shown that the assumption of circumferentially uniform heat flux on the inner surface of the cladding is valid for any practical fuel subassembly designs of a sodium-cooled reactor for a central-station power plant. Of the three prime independent variables, the P/D ratio has by far the greatest influence on the heat transfer behavior of the system; and of the remaining two variables, the influence of the k_w/k_f ratio is about the same as that of the $(r_2-r_1)/r_1$ ratio at the lower values of $(r_2-r_1)r_1$, but appreciably greater at the higher values of $(r_2-r_1)/r_1$. The greater the P/D ratio and the lower the other two ratios, the more the system behaves like the standard uniform-wall-heat-flux case. The results are all expressed in the form of convenient dimensionless groups and are correlated by simple mathematical expressions, for ready use by the design engineer. (auth)

50125 NUCLEAR REACTORS. Ebeling, Douglas Roy; Bicevskis, A. (to United Kingdom Atomic Energy Authority). British Patent 1,204,375. 9 Sep 1970. Filed 2 Aug 1967.

Reference is made to light water cooled natural U reactors of the pressure tube type. In these reactors the quantity of coolant in the tubes must be reduced to a minimum, owing to its high neutron absorption. In the system described the fuel in each tube comprises closely spaced parallel fuel elements arranged on a lattice to form a cluster of rectilinear cross section, and the voids bounded by the sides of the clusters and the internal walls of the pressure tubes contain solid material of low neutron absorption cross section. The rectilinear lattice arrangement of fuel elements enables small and uniform interspacing of the fuel elements to be achieved and the solid material serves to replace coolant water which would normally occupy the voids, thereby increasing the fuel/coolant ratio. Suitable solid materials are graphite, Be and Mg. The fuel elements are preferably arranged in triangular lattice pitch to form a cluster of generally hexagonal cross section and graphite bars of segmental cross section are contained within the segmental voids. The graphite bars may be secured to the sides of the fuel element cluster so that they can be inserted and withdrawn from the pressure tube with the cluster. (UK)

50126 HEAT TRANSFER TEST LOOP FOR DEVELOPMENT OF ADVANCED THERMAL REACTOR. Hada, Mikio (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan); Hoshi, Akio; Shinnai, Kazuhiko; Yoshioka, Katsumi; Kagawa, Tatsuo. Toshiba Rebyu; 25: 1007-14(Aug 1970). (In Japanese).

The largest boiling test loop in the world has been completed by Toshiba and turned over to its owner, the Power Reactor and Nuclear Fuel Development Corporation, at Oarai Engineering Center. The test loop has been built to supply technical information of thermal and hydrodynamic characteristics of the fuel element for the Advanced Thermal Reactor, heavy-water-modulated and boiling-light-water type, which is to be built and operated by 1975. The test loop has an output capacity of 8,000 kW and is capable of operating at a maximum pressure of 100 kg/cm^2 and a temperature of 310°C. The equipment has been designed and fabricated on the basis of the ample experience for the boiling test facilities developed and operated by Toshiba. (auth) (Japan)

Auxiliary and Emergency Systems

Refer also to abstract 50064.

50127 (IN-1388) REVIEW OF HEAT TRANSFER COEFFICIENTS FOR CONDENSING STEAM IN A CONTAINMENT BUILDING FOLLOWING A LOSS-OF-COOLANT ACCIDENT. Slaughterbeck, D. C. (Idaho Nuclear Corp., Idaho Falls). Sep 1970. Contract AT(10-1)-1230. 20p. Dep. CFSTI.

A literature search of available technical publications, and a survey of recent experiments and current practices relevant to the prediction of heat transfer in a containment building following a loss-of-coolant accident have been completed. Very little information with direct applicability to large power reactor containments is available on which to base concrete recommendations. A correlation based on the work of Tagami is suggested for use in safety analyses because its trend is consistent with the Carolinas Virginia Tube Reactor (CVTR) measurements and because its use leads to predicted containment pressures being higher and thus more conservative than those measured at CVTR. This conservatism is desired because of the uncertainty associated with extrapolating results from typical small-scale experiments to large power plants. (34 references) (auth)

50128 (NEDO-10208) EFFECTS OF FUEL ROD FAILURE ON ECCS PERFORMANCE. Liffengren, D. J. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug 1970. 106p.

Experimental and analytical investigations of the effect of fuel rod failure caused by deformation of the Zircaloy cladding following a postulated loss-of-coolant accident have been conducted. The over-all results indicate that the maximum expected distortion as a result of bowing, ballooning, and perforation of the cladding would not significantly change the ability of the BWR emergency core cooling system (ECCS) to accomplish its design objective. Furthermore, the BWR ECCS can withstand significant degradation before any gross core damage, (i.e., loss of geometry) could result. 27 references. (auth)

50129 EMERGENCY CORE-COOLING PROBLEM IN LMFBR'S. Charak, Ira (Argonne National Lab., Ill.). Reactor Technol; 13: 280-309(1970).

The problems associated with emergency core-cooling systems (ECCS's) in liquid-metal-cooled fast breeder reactors (LMFBR's), including the requirement to keep the core submerged at all times, are generally discussed. Specific observations are made on solutions incorporated in all the major existing fast reactors. On the basis of claims made by the designers, design criteria for the respective ECCS's are inferred. It is concluded that emergency core cooling by natural convection is more feasible in loop-type LMFBR's than in pool-type LMFBR's. However, the requirement that the core remain submerged for a variety of assumed violations of the coolant boundary is felt to be more easily fulfilled in a pool-type LMFBR. 32 references. (auth)

50130 RELIABILITY ANALYSIS OF AN ELECTRICAL SUPPLY SYSTEM FOR A NUCLEAR POWER STATION. Smith, E. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design; 13: 216-21(Aug 1970).

The calculation was carried out at certain specific times during the routine maintenance cycle of the items of equipment within the system. These times are expressed as fractions of the complete maintenance cycle and the results against each time show the sort of variations that can take place in the overall probability of failure. This means that the probability of failure in the light of a demand for action depends, to some extent, on the actual time of the demand. For random demands, a "mean" probability of

failure can be calculated and this, in fact, is equivalent to the fractional dead time of the system. (auth)

50131 RELIABILITY ANALYSIS OF MECHANICAL EQUIPMENTS AND SYSTEMS. Hensley, G. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design; 13: 222-6 (Aug 1970).

A method is presented for predicting failure rates of mechanical instrumentation equipment. Provided that the component failure rates are known and also the environmental conditions likely to be met, it should be possible to extend this technique to much larger items of equipment, e.g., pumps, blowers, engines. Where such equipment is used to make up a highly reliable system such as a plant shutdown system, the overall reliability that can be achieved may be dependent on the frequency of common faults. (auth)

50132 IMPROVEMENTS IN BURNER-FLAME ARRESTER FOR BURNING OFF-GAS FROM A BOILING WATER REACTOR POWER PLANT. (to General Electric Co.). British Patent 1,208,089. 7 Oct 1970. Priority date 29 Oct 1968, United States.

50133 REFUELING ARRANGEMENTS FOR NUCLEAR REACTOR INSTALLATIONS. (to United Kingdom Atomic Energy Authority). British Patent 1,204,703. 9 Sep 1970. Filed 15 Aug 1967.

Reference is made to pressure tube reactors of the steam generating heavy water type (SGHW). Problems arise in such reactors in providing efficient but simple refuelling apparatus for lifting and lowering the fuel sections out of or into the tubes, and the problems are enhanced by the fact that the access ends of the coolant tubes are submerged in a pond of water above the reactor core and deep enough to contain the vertically disposed fuel assembly sections. Hoists have been proposed for the refuelling apparatus, but because functions other than lifting and lowering are required, such as release of closure plugs, the construction may be complex and expensive. In the system described the refuelling apparatus comprises a hydraulically operated telescopic ram unit which consists of an elongated cylinder having two rams one of which is slidable within the other; a grab is attached to the second ram for handling fuel assemblies or parts thereof, and a latch is provided for latching the second ram to the first. The latch is adapted to unlatch the rams on abutment of the latch with a tube end. (UK)

50134 BWR SIMULATOR TRAINING. Gridley, R. L. (General Electric Co., San Jose, Calif.); Guppy, W. H.; Perkins, K. T. Nucl. News; 12: No. 11, 53-6(Nov 1969).

The use of a simulator to train operating personnel is described. Evaluation of the training program is presented. (D.C.C.)

50135 PWR SIMULATOR TRAINING. Deddens, J. C. (Babcock and Wilcox Co., Lynchburg, Va.). Nucl. News; 12: No. 11, 50-3(Nov 1969).

The use of a simulator to train operating personnel is described. A training schedule is outlined. (D.C.C.)

50136 DEVICE FOR REMOTE POSITIONING OF A THERMOCOUPLE. Lion, Noel (to Commissariat a l'Energie Atomique). British Patent 1,207,928. 7 Oct 1970. Priority date 27 Sep 1968, France.

REACTORS, FAST—remote handling equipment for liquid sodium cooled, description of thermocouple
REACTORS, LIQUID METAL-COOLED—remote handling equipment for fast, description of thermocouple
REMOTE-HANDLING EQUIPMENT—design parameters of thermocouple in-core placement
THERMOCOUPLES—placement in liquid metal cooled fast reactors, description of remote handling equipment for (D.C.C.)

50137 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Lepert, Claude; Sauvage, Michel (to Commissariat a l'Energie Atomique). British Patent 1,207,120. 30 Sep 1970. Priority date 13 Sep 1968, France.

REACTORS, FAST—emergency core cooling system for liquid metal cooled, description of laminated metal core casing for
REACTORS, LIQUID METAL-COOLED—emergency core cooling system for fast, description of laminated metal core casing (D.C.C.)

Operation and Economics

Refer also to abstract 49998.

50138 (AEEW-R-652) ODYSSEUS 6: A COMPREHENSIVE FUEL MANAGEMENT CODE FOR AGR's. Buckler, A. N. (Atomic Energy Establishment, Winfrith (England)). Mar 1970. 37p. Dep. CFSTI (U. S. Sales Only).

A highly automated scheme of fuel management calculations is described for Advanced Gas-cooled Reactors with on-load, continuous refuelling incorporating a novel power shaping calculation, by which controllers can be set to yield desired reactivity and regionwise reactor powers. The calculations are restricted to two dimensions and two neutron groups. 9 references. (auth) (UK)

50139 (CONF-700401-, pp 3-33) DRAGON OPERATING EXPERIENCE. Chapman, B. G. (Atomic Energy Establishment, Winfrith (England)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27-30, 1970, Oak Ridge, Tennessee.

The use of Dragon as a fuel irradiation facility has generated a great deal of experience in operational areas such as helium utilisation and engineering, maintenance of helium circuits, activity behaviour in HTR circuits, and the detection and clean-up of chemical impurities. This experience over the last five years at Dragon is described. It is frequently difficult to predict the operational performance of large plants from the drawing board and the chief value of experience is to establish the practical limits which can be achieved. In this respect Dragon has demonstrated the essential viability of the HTR concept and has enabled realistic design criteria to be laid down. (17 references) (auth)

50140 (CONF-700401-, pp 34-59) OPERATING EXPERIENCE WITH THE AVR EXPERIMENTAL POWER STATION. Hantke, H. J. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)); Ivens, G. P. (Arbeitsgemeinschaft Versuchs-Reaktor G.m.b.H., Duesseldorf (West Germany)); Nephew, E. A. (Oak Ridge National Lab., Tenn.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27-30, 1970, Oak Ridge, Tennessee.

The operating performance of the AVR experimental power station during its commissioning program as well as power operations following customer acceptance of the plant in May 1969 is described. The plant outages, which have occurred since the power commissioning program began on December 18, 1967, are enumerated and evaluated according to their nature and duration. The overall plant availability, to March 31, 1970, has been gratifyingly high and amply demonstrates the feasibility of the pebble bed reactor concept. (auth)

50141 (CONF-700401-, pp 649-70) SOME FEATURES OF THE LOW ENRICHMENT HTR FOR VARIOUS FUEL ELEMENT DESIGNS. PART 1. PARAMETRIC FUEL CYCLE SURVEYS. Graziani, G.; Rinaldini, G.; Zanantoni, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center); Bairiot, H.; Haubert, P. (Societe Belge pour l'Industrie Nucleaire, Brussels); Ghilardotti, G. (Agip Nucleare, Milan (Italy)); Baur, M. (Gutehoffnungshuette Sterkrade A.G., Oberhausen (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27-30, 1970, Oak Ridge, Tennessee.

The fuel cycle cost is assessed in terms of very few parameters which have a paramount effect on the physical performance of the fuel. An attempt is made to pinpoint such "predominant" parameters which will allow, on the basis of their choice alone, a good prediction of the physical and economical performance of the fuel considered. The work is based on a number of fuel cycle surveys, the most recent with four fuel element concepts: the hollow rod, the tubular, the teledial, and the trefoil fuel element. The survey described was performed for two values of the core-average power density, varying the burn-up and the moderation ratio within the range of interest. The variation of C/U238 was obtained by varying the heavy metal density, while the geometry (fuel dimensions and lattice pitch) was kept constant. This simplified approach was adopted for the present survey, as previous work had shown that the whole range of interesting values of the parameters which determine the fuel cycle physics and economics can be covered in this way. 7 references. (auth)

50142 (CONF-700401-, pp 671-93) SOME FEATURES OF THE LOW ENRICHED HTR FOR VARIOUS FUEL ELEMENT DESIGNS. PART II. COMPARISON OF THE FUEL ELEMENT DESIGNS. Bairiot, H.; Haubert, P. (Societe Belge pour l'Industrie Nucleaire, Brussels); Bauer, M. (Gutehoffnungshuette Sterkrade A. G., Oberhausen (West Germany)); Ghilardotti, G. Agip Nuclear, Milan (Italy)).; Graziani, G.; Rinaldini, C.; Zanantoni, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The fuel cycle costs are assessed for the four elements considered in Part I, two power densities, two Xenon override requirements, and two cost assumptions. Under the cost assumptions described, the fuel cycle was found to be 18% lower for the low fabrication cost assumption than for the high fabrication cost assumption. The equilibrium fuel cycle cost as assessed is not a sufficient criterion for the selection of the fuel design and the fuel cycle characteristics. The fuel cycle cost should first be corrected for the approach to equilibrium period. The influence of this period is illustrated. Furthermore, the capital cost may be influenced by some fuel characteristics such as the power density. This effect is assessed for the four element designs. (auth)

50143 (CONF-700401–, pp 694–709) COMPARISON OF HTGR FUEL CYCLES FOR LARGE REACTORS. Dahlberg, R. C. (Gulf General Atomic, Inc., San Diego, Calif.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

Minimum fuel cycle costs consistent with design objectives on power peaking and fast fluence can be achieved in large HTGRs with a fuel cycle defined by a 4 year fuel lifetime, a power density of 8 w/cc, and a C/Th ratio of 250 to 300. This is the basis for current large HTGR design efforts. Recycle of the bred U-233 will be undertaken as soon as the necessary processing facilities are available. Plutonium is an attractive makeup fissile material in the HTGR. The use of 300 μ fuel particles provides a significant and beneficial self shielding of the ^{240}Pu resonances, and the resultant indifference value is about $9.80/gm fissile. Moreover, the fuel cycle cost can benefit from a weakness in the cost of plutonium obtainable on the open market. For example, if plutonium were available at $8/gm fissile, as might be the case based primarily on a LWR market, then the fuel cycle cost using plutonium makeup fuel in the HTGR would be reduced by 0.11 m/kWh over the reference case with ^{235}U as the feed fuel. At the present time, the low enrichment cycle for a fuel element design similar to that developed for the Fort St. Vrain HTGR results in net depletion and fuel inventory costs which are .2 to .3 m/kWh more expensive than in the thorium cycle. Possible lower handling costs associated with the uranium cycle are not expected to change this cost disadvantage significantly. Enrichment requirements are about 12% for the optimum economics, but the fuel cycle cost is not critically sensitive to the enrichment. (auth)

50144 (CONF-700401–, pp 710–25) ECONOMICS OF RECYCLE IN LWR's AND HTGR's IN THE U. S. CONSULTANT'S POINT OF VIEW. Macnabb, W. V.; Scarborough, J. C. (NUS Corp., Rockville, Md.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory. April 27–30, 1970, Oak Ridge, Tennessee.

Since the water reactor is the immediate competition for the HTGR, the HTGR thorium fuel cycle with ^{233}U recycle and the LWR uranium cycle with plutonium recycle is compared in a self-consistent manner utilizing discounted cash flow evaluation techniques common for this purpose as a basis for comparison. At the heart of the HTGR evaluation are the economic dependences assumed for such parts of the fuel cycle as fabriction, shipping, reprocessing and refabrication, bred ^{233}U value, and so on. Selection of these data for the HTGR fuel cycle requires considerable judgment as to the rate of industry growth (throughput as a function of time), projected costs for commercial processing plants, and environmental constraints on plant size as these affect achievable levels of heavy metal throughput per unit of capital invested. Bases for these economic considerations are presented. The view of the utility industry in an as yet undemonstrated fuel cycle is presented as conservative since normal market forces are not as yet operative. Of equal interest to utilities is the cost structure or economic characterization of the entire fuel cycle, particularly those components that prospectively lie within their control. The fuel cycle cost structure for the LWR and HTGR is examined in terms of differences in the makeup of the direct and indirect fuel costs. In addition, the sensitivities of both fuel cycles to certain variables such as plant capacity factor, value of bred fissile inventory relative to ^{235}U, ^{238}U penalty effects on refabrication costs, and other variations in the respective fuel cycles are assessed. From these analyses, the HTGR fabrication cost target for a given reprocessing cost is developed for graphite fuels to achieve parity with current competing light water commercial nuclear fuel offerings, in view of prospective market developments for each system. (13 references) (auth)

50145 (CONF-700401–, pp 726–53) PARAMETRIC SURVEY ON FUEL CYCLES AND TOTAL GENERATING COSTS FOR HTR's WITH HOLLOW ROD, TELEDIAL AND TUBULAR INTERACTING FUEL ELEMENTS. Gutmann, H.; Daub, J.; Pedersen, J.; Schober, H. (Atomic Energy Establishment Winfrith (England)); Rinaldini, C.; Graziani, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center); Journet, J.; Malherbe, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

Total generating costs and fuel cycle costs are given for low enriched homogeneous design HTR's with hollow rod and teledial prismatic fuel elements which are the types considered for the first large HTR stations to be built in Europe. As a more advanced design, the tubular interacting concept which requires more extensive proof testing before it can be introduced has been investigated for both low enriched and thorium/highly enriched fuel cycles. The designs are investigated with respect to the manufacturing and design limits at present recommended by Dragon on heavy metal loading, fast neutron dose, surface and fuel temperature limits. The design assessments are made for various power densities on the basis of unirradiated fuel geometries for varying fuel temperature limits. Supplementary studies relate these results to the worst heat transfer condition during irradiation and include systematic and random error assessments. The total electricity generating costs include presently realistic fuel fabrication and capital cost estimates selected according to the principle that only technical and economic considerations determine the choice of contractors. (6 references) (auth)

50146 PROSPECTS FOR THE THTR. Atomwirt., Atomtech.; 15: 369(Aug 1970). (In German).

Completion of the first THTR is projected for 1976. At that time 10,000 MW(e) of nuclear energy will be installed in West Germany almost entirely based on light water reactors. As to the chances of the THTR to compete with the light water reactors, production of electricity and heat must be considered separately. As far as electricity is concerned, costs are expected to be slightly higher; however, the safety of the plant appears far superior. Reactivity can be regulated as required and the high heat capacity of the core after shutdown causes such degree of safety that installation close to large cities is feasible. As far as heat is concerned, the reactor can produce steam from 900 to 1000°C. The economic utilization of the heat is being evaluated. (H.B.G.)

50147 DEPLETION ANALYSIS OF NUCLEAR REACTOR FUEL ELEMENTS. Reeve, Harold Richard. Lafayette, Ind.; Purdue Univ. (1969). 262p. University Microfilms Order No. 70-8955.

Thesis.

A calculational model, embodied in the computer program CAROL–A, was developed as a basis for an operational aid system for thermal reactors. The program is based on multi-energy group diffusion theory for the fast neutron reactions and transport theory for the thermal neutron reactions. The program performs cross section calculations using an HRG–THERMOS calculational scheme. CAROL–A will also calculate the temperature distribution across a fuel element based on the non-uniform power distribution and the change in fuel thermal conductivity with depletion. The integral combination of reactor physics and temperature calculations offers a unique opportunity to study the interrelationships between factors which depend on the temperature of the media. A comparison of experimental results of the Yankee Reactor with the results of the programs LASER, LEOPARD, and CAROL–A was made. CAROL–A calculations compare favorably with the experimental results for the prediction of uranium isotopic and total plutonium production as a function of depletion. However, the relative isotopic concentration of individual plutonium isotopes show considerable disagreement. An investigation of the effect of various input options on the accuracy and economy of calculations was performed. The results indicate that flux calculations should be made at approximately every 2000 MWD/MTU depletion with power adjustments at each 100 MWD/MTU. At least 10 mesh points should be used to describe the fuel region for flux calculations and as many regions as feasible used for depletion calculations. The overriding consideration, in regard to economy of calculation, is shown to be the question of at what point in the calculation should microscopic cross sections be revaluated. Results indicate that if accurate plutonium isotopic content is desired, thermal microscopic cross sections should be revaluated as often as possible, and if a relative error of 2% change in isotopic prediction is acceptable then fast microscopic cross sections need to be calculated only initially. (Diss. Abstr.)

50148 STEAM-COOLED ThO_2–$^{233}UO_2$ FUELED FAST REACTORS. Freeman, Thomas Raphael. Lafayette, Ind.; Purdue Univ. (1969). 71p. University Microfilms Order No. 70-8891. Thesis.

The physics and economics behavior of two types of ThO_2-UO_2 fueled, steam-cooled, fast reactors are investigated in order to determine their feasibility as large central station power plants. Two similar reactors using UO_2-PuO_2 are also investigated so that the thorium fuel cycle can be compared to the plutonium fuel cycle. The first type of reactor uses high pressure steam at 3500 psi and is designed to have a high heat transfer rate and low fuel inventory. The second uses lower pressure steam at 1250 psi and is designed to have very little hydrogen in the core in order to obtain a hard neutron energy spectrum and a high breeding ratio. As a result of the design criteria, the low pressure reactors have higher breeding ratios and core loadings than the high pressure reactors. The requirement of high fuel burnup which is important to fast reactor fuel cycle economics also has a significant effect on these values. The breeding ratios for the cores in the just critical condition which have no excess fuel enrichment to achieve high burnup and in the start of life condition which have enough excess fuel enrichment to achieve 80,000 MWd/t using a batch loaded fuel management scheme are: 1.024 and 0.714 for the 3500 psi thorium core, 1.114 and 0.913 for the 1250 psi thorium core, and 1.140 and 0.966 for the 3500 psi plutonium core. The corresponding values for the fissile core loadings are: 1913 Kg and 2918 Kg for the 3500 psi thorium core, 3126 Kg and 3768 Kg for the 1250 thorium core and 2452 Kg and 3053 Kg for the 3500 psi plutonium core. The values for the 1250 psi plutonium core did not change because its breeding ratio (1.364) was high enough so that its reactivity increased during burnup and no extra fuel enrichment had to be added to its original core loading (3918 Kg) to achieve high burnup. From these values it is seen that the lower the initial breeding ratio the larger are the changes in the breeding ratio and core loading and consequently the more the fuel cycle cost was adversely affected by the added fuel in comparison to the 1250 psi plutonium core. In addition, the increase in the core loadings had the detrimental effect of increasing the reactivity of the start of life cores when voided, whereas initially the reactivity had decreased when the just critical cores were voided. This change in the void safety of the cores is due mainly to the decreased effectiveness of boron as a control poison as the spectrum hardens during voiding. Thus the 1250 psi plutonium reactor was the best reactor of the four studied from both the safety and economic standpoints. (Diss. Abstr.)

50149 TECHNICAL AND ECONOMIC ASSESSMENT OF DIFFERENT NUCLEAR PLANT TYPES. Dibelius, G. Mitt. Ver. Grosskesselbetr.; 49: 367-75(Dec 1969). (In German).

Technical and economic comparisons are made of light-water cooled, heavy-water cooled, advanced gas-cooled, high-temperature, and fast breeder reactors. Their electricity generating costs as a function of process efficiency, the effect of single or dual circuits, and temperature level of the working medium are compared. (UKAEA Info. Bulletin)

Safety and Siting

50150 (AHSB(S)R–187) PRESSURE AND ACTIVITY HISTORIES IN A VENTILATED CONTAINMENT FOR A NUCLEAR REACTOR DURING LONG-TERM HEAT ADDITION. Edwards, A. R. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). Jul 1970. 48p. Dep. CFSTI (U. S. Sales Only).

In reactor accident situations which do not involve near instantaneous rates of energy release to the containment volume, the time scale of energy removal may be of a similar order, leading to a finely balanced dynamic situation. Equations were derived governing such situations, when applied to a vented containment concept. These equations were used to carry out a parametric survey of the particular situation of a sodium fire, but the results may be adapted to many other situations involving reasonably slow rates of energy addition. It is concluded that there is little reason to demand a high design pressure for a containment building, since an appropriately sized vent plant associated with a low design pressure building can give the same degree of protection. However, the choice of too low a value for the design pressure should be avoided, otherwise an investigation into local pressure wave effects would be necessary. (auth) (UK)

50151 (CONF-700401–, pp 293-310) SAFETY ASPECTS OF HIGH TEMPERATURE REACTORS. Ashworth, F. P. O. (Atomic Energy Establishment, Winfrith (England)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The methods of assessing the fission product release and the graphite corrosion in a High Temperature Gas Cooled Reactor are reviewed. They are applied to a notional core to demonstrate the available margins and to indicate the priorities of information. These priorities are shown to be the objectives of the fission product and corrosion work underway in the Dragon Reactor Experiment programme. (auth)

50152 (CONF-700401–, pp 311-60) RELATION OF FISSION PRODUCT RELEASE LIMITATIONS TO THE DESIGN AND OPERATION OF A LARGE H.T.R. STATION. Flowers, R. H. (Atomic Energy Research Establishment, Harwell (England)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

Key features concerning fission product release are examined. The most important fission product hazards in the HTR are ^{131}I, ^{133}I, ^{137}Cs, ^{134}Cs, ^{90}Sr, ^{85}Kr, ^{89}Kr and ^{137}Xe. Release of Cs and Sr, while basically controlled by the fraction of broken particle coatings, is strongly influenced by fuel tube surface temperature. The latter temperature should be given some consideration together with the particle temperature when setting design limits. Release of I_2 and rare gases is controlled by the fraction of broken particle coatings and by the particle temperature. Gaseous precursors may be the major source of metal fission product release during early fuel pin life, particularly at the lower temperatures. Data on diffusion, adsorption and plate-out of fission products is at present insufficiently accurate and complete to allow a confident assessment of allowable particle breakage fraction. However, on the basis of reasonable assumptions, allowable fractions have been estimated for a variety of operating temperatures. A new in-pile loop, to be built at Harwell, is described. Its function will be to confirm or correct assumptions and calculations of the type presented. (30 references) (auth)

50153 (CONF-700401–, pp 879-89) SAFETY STUDIES FOR THE GAS-COOLED FAST REACTOR. Larrimore, J. A.; Waage, J. M. (Gulf General Atomic, Inc., San Diego, Calif.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The status of the joint East Central Nuclear Group-General Atomic program on safety aspects of the Gas-Cooled Fast Reactor (GCFR) is presented. Intrinsic and design safety features of the GCFR, studies of anticipated operational occurrences, studies of design-basis accidents, and containment studies are reviewed. The close relationship of GCFR technology to HTGR technology is discussed, and the differences between GCFR and LMFBR safety considerations are pointed out. (auth)

50154 (CONF-700401–, pp 890-906) SAFETY AND AFTER-HEAT REMOVAL STUDIES OF THE GAS-COOLED FAST REACTOR. Walker, C. S. (Oak Ridge National Lab., Tenn.).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

The temperature variations in the fuel and cladding following loss of heat removal capability, models to represent core melting and movement, and the cooling required to contain a molten core have been studied. A 1000 MW(e) GCFR having a multicavity vessel, six main coolant loops, and two auxiliary coolant loops was taken as the plant model. The minimum mass flow to limit the maximum fuel cladding temperature to 1800°F after a depressurization to 15 psia on a 30-sec time constant was found to be almost 1% of the design value. Melting of the cladding would begin within a few seconds if the coolant were lost to 0.1% of the design value on a 1-sec time constant. Fuel melting and compaction would take several minutes, and compaction would not occur if fuel fell from the core volume. It appears feasible to contain the molten core on the vessel liner above the bottom head of the reactor vessel if the vessel liner cooling is increased to a total water flow of 25,000 gpm. The accidents examined are limiting cases having very low probability of occurrence, but should be of value in selecting the design-basis accidents. (9 references) (auth)

50155 (IN–1392) MOXY: A DIGITAL COMPUTER CODE FOR CORE HEAT TRANSFER ANALYSIS. Evans, D. R. (Idaho Nuclear Corp., Idaho Falls). Aug 1970. Contract AT(10-1)-1230. 31p. Dep. CFSTI.

The core heat transfer code MOXY was developed for predictive and post-test analysis of core heat transfer during LOCA. The code employs models that describe thermal radiation, conduction, and convection to steam, and incorporates the following advances in the heat transfer models over previous versions: the fuel rod

and sink conduction models use an implicit numerical integration technique that has unconditional numerical stability; and the code solves a three-dimensional core model. The code developed has been evaluated by comparisons between calculated rod surface temperatures and experimental temperatures. These comparisons indicate that the assumptions in MOXY regarding gray diffuse surfaces and symmetry are realistic. 15 references. (auth)

50156 (WCAP-7435) PWR FULL LENGTH EMERGENCY COOLING HEAT TRANSFER (FLECHT) GROUP I TEST REPORT. Cermak, J. O.; Kitzes, A. S.; Cadek, F. F.; Leyse, R. H.; Dominicis, D. P. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Systems Div. Idaho Nuclear Corp., Idaho Falls). Jan 1970. Subcontract S-7045 (C-625). 222p. Dep. CFSTI.

The objective of the PWR Full Length Emergency Cooling Heat Transfer (FLECHT) test program is to obtain experimental data for use in evaluating the heat transfer capabilities of pressurized water reactor emergency core cooling systems under simulated loss-of-coolant accident conditions. The results of the 51 runs of the Group I test series are summarized. Transient heat transfer coefficient and clad temperature behavior, at different radial test bundle locations and at various axial locations, were investigated over a selected range of parameters. The effects of borated coolant and simulated flow blockage due to clad swelling were also investigated. Typical axial and radial pressure drop data, local coolant thermocouple data and measurements of carry-over water are presented. The current test results verified the ability of a bottom-flooding emergency core cooling system design to terminate temperature increase during a loss-of-coolant accident. 4 references. (auth)

50157 APPLICATION OF RISK ALLOCATION TO REACTOR SITING AND DESIGN. Otway, Harry John. Los Angeles; Univ. of California (1969). 153p. University Microfilms Order No. 70-8186.

Thesis.

A method is proposed for the assessment of reactor safety, based upon the individual mortality risk, which features: (1) the evaluation of safeguards in terms of the reduction in risk provided; and (2) the determination of site exclusion radii. Accidents were divided into two broad categories: those due to the random, independent failure of systems; and "site-induced" accidents caused by phenomena peculiar to the site (such as earthquakes) which can destroy the independent operation of systems. Random failures were further sub-divided into those involving either a reactivity malfunction or a fault in the reactor cooling system—one of these being implicit in a large accident. The method, which considers the probability of initiating events such as operator error, was applied to a typical 1000 MW(e) PWR and the curve of fission product release versus accident probability was determined for each of these fault types. The system failure rates used in this application were derived from a literature search. The upper limit of individual risk was obtained by assuming all releases to occur with the wind into the same sector under inversion conditions. The thyroid dose due to iodine isotopes and the whole-body dose due to ground-deposited isotopes were considered without evacuation. A survey of the medical literature led to the use of 1×10^{-4} per person per rem as the mortality risk from thyroid irradiation. A threshold value of 1 rem was assumed. The corresponding numbers for whole body irradiation were found to be 30×10^{-4} per person per rem and 100 mrem. Application of these dose and risk criteria to the fission product release vs. probability curve, when integrated over accident probability, yields the total individual mortality risk per year against distance. An evaluation of societal acceptance of various levels of accidental risk resulted in selection of 10^{-7} as an acceptable yearly death risk to the individual from a nuclear plant. This value was proposed for the nearest resident based upon continuous exposure. For the example reactor an exclusion radius of 350 meters would give this risk at the site boundary. For urban population of 50 persons per acre out to 100 km the total risk was 0.003 deaths in a 30 year reactor lifetime. Analysis of these results showed that they were relatively insensitive to accidental probability and radiation threshold. The fission product release vs probability relationship for earthquake-induced accidents was semi-quantitatively examined. The conclusion here was that earthquake risks must be examined on the same time scale as other reactor risks. This implies that low-probability, high-consequence earthquakes are important when risk is used as the siting criterion so that the earthquake risk is presently the most significant unknown. The calculated risk from reactivity accidents was insignificant compared to that from loss of coolant accidents—indicating an area of safeguard design imbalance. Due to past emphasis on the MCA, most of the integrated risk was found to come from the relatively frequent, low-consequence accidents so that any further reduction in risk must come from improvements in primary system reliabilities rather than through additional safeguard efforts. Based upon the mortality risk concept (neglecting the earthquake risk), the siting of thermal reactors of 1000 MW(e) capacity need be restricted only by the physical size of the facility. (Diss. Abstr.)

50158 LMFBR SAFETY. I. FISSION-PRODUCT BEHAVIOR IN SODIUM. Castleman, A. W. Jr. (Brookhaven National Lab., Upton, N. Y.). Nucl. Safety; 11: 379-90(Sep-Oct 1970).

The potential hazard presented by the possibility of fission-product and plutonium transport from liquid-metal-cooled reactors into the environment is a major factor in reactor siting, design, and operation. Fortunately considerable information on the behavior of fission products in sodium systems is available with which to assess their fate under conditions likely to exist both during reactor operation and in the event of an accident. Xenon and krypton are the only fission products that exert large partial pressures and are the only ones likely to be significantly released in the absence of extensive sodium vaporization. Under inert conditions fission-product iodine reacts with sodium and, except possibly at high concentrations within the sodium thermal bond of a fuel element, will probably be retained in the liquid sodium. The alkaline metals will distribute between the coolant and the surfaces exposed to sodium, although large fractions will vaporize in the event of significant sodium vaporization. Analysis of the behavior of barium and strontium requires further study; however, it is known that their volatility is low, and they will probably interact with the oxygen dissolved in reactor-grade sodium and deposit on the primary-system piping. Calculational methods are available for predicting the maximum extent of vaporization of Cs, Rb, Sr, I (as NaI), Ba, Te, and Sb as a function of sodium vaporization. 38 references. (auth)

50159 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. Nucl. Safety; 11: 404-19(Sep-Oct 1970).

50160 QUANTITATAIVE SAFETY ANALYSIS. Nucl. Eng. Design; 13: 183-244(Aug 1970).

Included are 10 papers on the probability approach applied to nuclear reactor safety assessment. A separate abstract was prepared for each of the papers. (H.D.R.)

For abstracts of individual papers see: 50105, 50130, 50131, and 50161–50167.

50161 SAFETY CRITERIA. Bell, G. D. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design; 13: 187-90(Aug 1970).

The representation of a safety criterion for reactors by means of a frequency distribution of curie releases conforms with a realistic philosophy of safety in which all sequences of events not at variance with the laws of nature are to be given consideration. The criterion has been given a precise interpretation and can be used directly by designers and by safety assessors in evaluating the adequacy of the safety provisions. To accomplish this evaluation the method has stimulated examination of reliability considerations of systems and components and the accumulation of reliability data. By evaluating the consequences to the population around a site arising from a reactor conforming with the release criterion, it is possible to compare the nuclear risk with risks arising from other activities of man and with natural risks. (auth)

50162 TECHNIQUES OF QUANTITATIVE RELIABILITY ANALYSIS. Bourne, A. J.; Green, A. E. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design; 13: 191-200(Aug 1970).

The numerical reliability analysis of a system involves the theory and mathematics of probability and statistics. Various reliability parameters may be calculated for any system and it is important to decide exactly which are the parameters of interest. The type of mathematical model used to determine the parameter of interest depends upon the pattern of failures occurring within the system, the way the system is operated and maintained, the environment and purpose of the system and the interacting effects and requirements of other related systems. All aspects must be considered since misleading results may be produced by using a wrong or over-simplified mathematical model. The successful application of a correct model then depends on the use of the right substantiated values for the numerical parameters to known limits of confidence. The logical representation of the mathematical model and its solution may be carried out in a number of different ways. For relatively large and complex systems the process is greatly expedited by using a computer program. The final reliability number calculated for a system may be used as an absolute value in connection with some overall reliability requirement or as a comparative value in association with other similar systems. The reliability numbers, however, will generally have many

crucial assumptions associated with them and so any results of analysis quoted should always highlight these assumptions and define precisely what the results mean. Used in this way, reliability analysis can be an extremely valuable tool in the overall process of performance assessment. (auth)

50163 ANALYSING COMPLEX SYSTEMS. Woodcock, E. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design; 13: 201-10(Aug 1970).

The steps necessary to carry out a complete reliability analysis of a system are examined. The reliability characteristics for each individual device are defined in the form of relevant analytical or mathematical expressions. The next steps are to feed numerical values into these expressions and use them to obtain "probabilities of failure" from the logic sequence diagram. Methods of doing this for the large and complex systems which arise in safety analysis are discussed in detail. A short section considers methods of estimating time delays in operation, a factor which can be of importance in safety systems. (auth)

50164 RELIABILITY ANALYSIS OF ELECTRONIC EQUIPMENT. Eames, A. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design; 13: 211-15(Aug 1970).

It is necessary to predict the reliability performance for a system by theoretical means. In order to do this, it is necessary to establish the failure rates of the electronic equipment and other constituent parts of the system. The population sizes of equipment and parts are usually sufficient to enable their failure rates to be established by practical as well as theoretical means. It is also necessary in assessing equipment to ensure that it is capable of doing its job and this involves analyzing such aspects as response time, accuracy, and stability, as well as the reliability. The failure rate assessment of electronic equipment is discussed briefly. (auth)

50165 DATA COLLECTION FOR QUANTITATIVE SAFETY ANALYSIS. Ablitt, J. F.; Eames, A. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design; 13: 230-5 (Aug 1970).

Arrangements for the establishment of a reliability data collection scheme for the quantitative assessment of basic failure rate data on nuclear plant equipment and components are outlined. (H.D.R.)

50166 TECHNIQUES FOR CONSEQUENCES ASSESSMENT. Bowen, J. H. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design; 13: 236-9(Aug 1970).

A safety criterion is described by a "probability consequences" diagram and provides a useful framework within which: (a) A tentative assessment may be made of the demands which a given proposal is likely to make on equipment and material performance; thus schemes may be compared and the work needed to prove a given scheme may be estimated. (b) Logical interpretations may be given to the degree to which statements and arguments should be substantiated; thus requirements for information may be specified, experiments and tests devised, and operational and maintenance procedures agreed. (auth)

50167 RISK ASSESSMENT. Beattie, J. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design; 13: 240-2(Aug 1970).

It is concluded that the risk from reactors located as at present is low. The chance is smaller than once in a hundred thousand years of an event causing between a hundred and a thousand cases of thyroid cancer, if, improbably, no medical supervision whatsoever is subsequently provided. It is apparent that there are but moderate reductions in risk—about one order of magnitude in probability of a given number of cases—to be gotten from practicable remote siting. In contrast to this, many orders of magnitude reduction should be achievable through careful attention to intrinsic reactor reliability and through tested reliable engineered safeguards. (auth)

50168 REACTOR SITING AND DESIGN FROM A RISK VIEWPOINT. Otway, Harry J.; Erdmann, Robert C. (Univ. of California, Los Angeles). Nucl. Eng. Design; 13: 365-76(Aug 1970).

A method for the assessment of reactor safety is proposed, based upon the individual mortality risk, which allows (1) the determination of necessary site exclusion radii; and the evaluation of safeguards in terms of the risk reduction provided. An application to a 1000 MW(e) PWR indicates that for a maximum individual mortality risk of 10^{-7} per year (at the site boundary) an exclusion radius of 350 m is required. For a densely populated urban site the total risk was found to be 0.003 deaths over a 30-year reactor lifetime. Risk was found to be not particularly sensitive to accident probabilities. (25 references.) (auth)

50169 PRINCIPLES OF UNIFIED SYSTEMS SAFETY ANALYSIS. Garrick, B. John (Holmes and Narver, Inc., Los Angeles). Nucl. Eng. Design; 13: 245-321(Aug 1970).

Unified Systems Safety Analysis (USSA) is a method for achieving safety control. In particular, it is a methodology for (1) interfacing safety analysis with the life cycle (concept development to system retirement) and different operating phases of a total system; and (2) logically developing a level of safety in terms of the likelihood and consequence of a specified undesired event. The principal point of view of USSA which differs from other methodologies relates to safety control. USSA has been evolved to both assess and monitor the level of safety while revealing necessary adjustments either in design, procedure, or both to sustain a prescribed level. Thus, "analysis" in reference to USSA is not to be interpreted in a passive sense as it relates to design. In particular, USSA is to effect design to the extent that design controls safety. To serve the desired monitoring function has required that particular attention be given to the effect of safety of plant operations. Thus, in the methodology considerable care has been taken to put the more analytical activities of safety analysis in context with the more routine activities of operations to assure to the extent possible their proper interaction. A successful execution of USSA depends on accurate descriptions of the systems involved, representative data, and suitable analytical techniques for implementation. The principal ingredients of USSA which are an easily understood activity network, the supporting mathematical analysis, and appropriate computational schemes are covered. (17 references.) (auth)

50170 REVIEW OF HAZARDS AND SOME THOUGHTS ON SAFETY AND SITING. Beattie, J. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 1-6 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

It is the usual procedure in assessing the safety of nuclear reactors and the suitability of potential sites for them, to make the postulate that a release of fission products has occurred in spite of all the inherent and engineered safeguards and all operational precautions. The probable consequences on the well-being of the general public are estimated with the maximum achievable accuracy and from this estimate and other considerations a judgment is made of the suitability of a particular reactor for a given site or of the relative merits of the available sites. The most hazardous component of a release and technical argument may center round the dose-response relationship assumed between the inhalation of iodine and the possible induction of thyroid cancer. However, the release of iodine could be greatly reduced in many cases by deposition of iodine within the reactor and its containing structures, and also by the use of filter and absorber systems to intercept the discharged activity. These would be expected to change the proportions of the fission products in the release, and in most cases they would be expected to reduce very significantly the hazard to the public. (auth) (UK)

50171 CURRENT SAFETY ASSESSMENT TECHNIQUES. Nicholson, H. M. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 7-11 of British Nuclear Energy Society Symposium on Safety and Siting, London, March 28, 1969. London; Institution of Civil Engineers (1969).

See CONF-690347.

During the past two years reactor safety assessment in the U. K. A. E. A. has moved progressively towards quantitative techniques and the so-called "probability approach" has now been widely adopted by assessors, designers and operators of nuclear plants. The experience accumulated to date in this field is reviewed by considering generally a number of assessment phases in logical sequence. At each phase the advantages and difficulties of the quantitative treatment are noted and the need for research or further data is recognized. It is concluded that the most important benefits of the quantitative technique lie in the intrinsically methodical approach employed and in the marked improvement in communication which results. (auth) (UK)

Power Conversion Systems

50172 (CONF-700401-, pp 231-50) DEVELOPMENT WORK FOR LARGE-SCALE NUCLEAR HELIUM TURBINE PLANTS WITH HIGH-TEMPERATURE REACTORS. Boehm, E.; Twardziok, W. (Gutehoffnungshuette Sterkrade A. G., Oberhausen (West Germany)); Oehme, H.; Weiskopf, H. (Brown, Boveri und CIE A. G., Mannheim (West Germany)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27-30, 1970, Oak Ridge, Tennessee.

The main part of the development programme for high-tempera-

ture reactors with helium turbine is proposed to be spent on test facilities and test work. Three test rigs for the non-nuclear tests on helium components and systems are described. The rigs are proposed to be erected jointly with the auxiliary installations in a common test field on the premises of KFA in Jülich. The problems of test work are briefly described by the two examples, hot gas valves and insulation. (auth)

50173 (CONF-700401–, pp 268–90) HTR DIRECT CYCLE: ENGINEERING POSSIBILITIES AND MATERIAL REQUIREMENTS. Lockett, G. E.; Huddle, R. A. U. (Atomic Energy Establishment, Winfrith (England)).

From Proceedings of the gas-cooled reactor information meeting at the Oak Ridge National Laboratory, April 27–30, 1970, Oak Ridge, Tennessee.

As a first step towards evaluating the practical possibilities, of the HTR direct cycle, recent Dragon Project work has selected a plant layout arrangement and produced a reference design. It has been used as a basis for sizing components, identifying problem areas and assessing the effects of heat exchanger performance, pressure drops, design configurations and gas temperature limits. When operating with helium at high core outlet temperatures and at the low and representative impurity levels expected in a closed cycle system, there is a need to show that the behaviour of any chosen high temperature material is completely satisfactory. A philosophy regarding the choice of materials and an indication from exploratory test results are given. A view on some of the problems foreseen and some of the proposed general solutions are given. It is concluded that there appears to be no insuperable problem but further study could lead to useful improvements. (auth)

50174 (WARD–4112-2(Vol.1)) LMFBR LOW CAPACITY IHX DESIGN STUDIES SUPPORTING FFTF DEVELOPMENT. VOLUME I. RESULTS, CONCLUSIONS, AND RECOMMENDATIONS. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jan 1970. Contract AT(30-1)-4112. 281p. Dep. CFSTI.

Design studies were conducted which support development of a Na-to-Na intermediate heat exchanger (IHX) of general size, type, and performance characteristics to be used in the Fast Flux Test Facility (FFTF) project. Volume I includes background information, detailed summaries, conclusions, and recommendations resulting from the studies. Appendices present the concept selection report, the suggested in-place tube plugging procedures, the suggested tube bundle removal procedures, the recommended test programs, specifications, and drawings that were developed. (H.D.R.)

50175 (WARD–4112-2(Vol.2)) LMFBR LOW-CAPACITY IHX DESIGN STUDIES SUPPORTING FFTF DEVELOPMENT. VOLUME II. SUPPORTING CALCULATIONS. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jan 1970. Contract AT(30-1)-4112. 214p. Dep. CFSTI.

A thermal and hydraulic performance analysis is presented for the Fast Flux Test Facility intermediate heat exchanger concept. Included are preliminary calculations on the major design and performance parameters, a preliminary stress analysis, and a preliminary vibration analysis. (H.D.R.)

50176 CO_2 GAS TURBINE POWER PLANT INCLUDING A NUCLEAR REACTOR AS HEAT SOURCE. Frieder, A. Canadian Patent 845,897. 30 Jun 1970. Priority date 27 Jul 1967, Switzerland.

A closed cycle CO_2 gas turbine power plant is described, employing a nuclear reactor as a heat source. Included for stabilization of the temperature and pressure of the CO_2 passing through the reactor is a bypass around the reactor and low pressure turbine. (F.S.A.)

50177 PROBLEMS SURROUNDING NUCLEAR GAS TURBINES. Gasparovic, Nebojsa (Technische Hogeschool, Delft, Netherlands). Brennst.-Waerme-Kraft; 22: 339–46(Jul 1970). (In German).

A "nuclear" gas turbine is characterized by a gas turbine process operating directly in a reactor circuit. The use of a direct circuit has its advantages and disadvantages, whereby in helium turbines the disadvantages predominate, particularly from the point of the safety requirements. Furthermore, the use of helium necessitates operating at high temperatures in order to achieve a high efficiency. This in turn requires the use of internal insulation in the tubes which reduces their energy conveying capacity. Where a pressure drop occurs, the safety requirements can only be met by making use of an integrated construction. Helium gas turbines cannot produce a greater power output per unit than steam turbines. 44 references. (auth)

50178 IMPROVEMENTS RELATING TO BOILING LIGHT WATER REACTORS. Sodergard, Bengt Martin (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 1,207,021. 30 Sep 1970. Priority date 14 Feb 1967, Sweden.

REACTORS, BOILING— steam treating system for, description of attachment mechanism for removable overhead (D.C.C.)

Research and Test Reactors

Refer also to abstracts 48211, 49876, 50050, 50053, 50055, 50086, 50123, 50174, 50175, and 50219.

50179 (AEEW-R-352) MEASUREMENT OF MATERIAL BUCKLING IN A LARGE HEAVY WATER MODERATED EXPONENTIAL ASSEMBLY. Austin, J. W.; Goddard, A. J. H.; Johnstone, I. (Atomic Energy Establishment, Winfrith (England)). Jul 1966. 33p. Dep. CFSTI (U. S. Sales Only). UK 8s.

Exponential measurements of neutron buckling have been made in a number of Steam Generating Heavy Water lattices, in the large exponential assembly known as SGHW I, at AEE Winfrith. The procedures adopted for the optimum adjustment of neutron source positions, for the analysis of harmonic effects and for the investigation and minimizing of random and systematic errors are described in detail. It is believed that these methods are adequate to determine a typical buckling of 3 m^{-2} to a statistical accuracy of ± 0.030 m^{-2} and that the additional contribution from systematic errors is not greater than ± 0.036 m^{-2}. It has been shown that the positions of flux peaks caused by cluster end plates in the axial distributions in these cores are moved vertically by about 2 cm. by the interaction with the macroscopic exponential flux distribution. Radial reflector savings have been shown to vary with core composition in a manner which is well predicted by a relatively simple theoretical calculation. This suggests that statistical errors in individual radial buckling determinations in lattices of this type could be reduced from ± 0.016 m^{-2} to ± 0.005 m^{-2} by collating radial reflector saving data from similar lattices. 12 references. (auth) (UK)

50180 (ANL–7538) PACKAGED LOOP FOR EBR-II: PRELIMINARY CONCEPTUAL-DESIGN STUDIES AND DISCUSSION OF POSSIBLE FUTURE WORK. EBR-II Project. Wilkes, Charles W.; Rice, Ralph E. Jr.; Adkins, Harold E. (Argonne National Lab., Ill.). Dec 1969. Contract W-31-109-eng-38. 103p. Dep. CFSTI.

A conceptual design of a packaged loop, which would be placed in one of the EBR-II control-rod positions, has been developed. The loop would have its own closed-circuit coolant system, which would be isolated from the reactor coolant. The capability of such a loop for higher temperatures, isolation from the reactor coolant, containment of failures, and independent control of power density, coolant flow, and sodium chemistry would permit the performance of several types of experiments that could not normally be conducted in the reactor. 36 references. (auth)

50181 (BNWL–1453) ANALYTICAL CORRELATIONS OF PRCF BATCH CORE FUELLED EXPERIMENTS. Mannan, M. A.; Matsuura, Shojiro; Preszbindowski, D. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1970. Contract AT(45-1)-1830. 94p. Dep. CFSTI.

A series of three critical experiments containing 2 wt. % plutonium enriched fuel has been performed in the Plutonium Recycle Critical Facility. These experiments were performed to provide information on some of the physics characteristics of the batch core. Analytical correlations were made with the data from these experiments in order to test the accuracy of calculational methods in their application to plutonium enriched reactor cores. Two computational systems called HTH and HAMMER were used in the study. Significant differences in HTH and HAMMER calculated results were noted and these differences were determined to result mainly from different epithermal cross-section libraries. The results of this study do not indicate a clear cut superiority of either HTH or HAMMER for plutonium fuelled cores. 20 references. (auth)

50182 (DOCKET-50231-58) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Spurious Low Flow Trip Signal. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 21 Sep 1970. 4p. Dep. CFSTI.

50183 (DOCKET-50231-57) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Quarterly Plant Operations Report No. 5, May 1–July 31, 1970. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 30 Sep 1970. 16p. Dep. CFSTI.

50184 (GA–10116(Rev.)) REANALYSIS OF PLUTONIUM LATTICE SPECTRAL DATA. Final Report, November 1, 1969–

April 30, 1970. Neill, J. M.; d'Oultremont, P.; Rindfleisch, C. J. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Apr 1970; Revised 30 Jul 1970. Contract AT(45-1)-1830. 272p. Dep. CFSTI.

For Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

Time-of-flight thermal neutron spectra measured at various positions and at different temperatures in H_2O-moderated lattices of Al–Pu fuel are presented. Problems encountered in the experimental data and solutions applied are described. Trends in the revised experimental data and comparisons to theory are presented. 14 references. (D.C.C.)

50185 (GA-10280) FAST REACTOR SPECTRUM MEASUREMENTS. Quarterly Progress Report for the Period Ending July 31, 1970. Young, J. C.; d'Oultremont, P.; Borgonovi, G. M.; Rindfleisch, C.; Profio, A. E. (Gulf General Atomic, Inc., San Diego, Calif.). 24 Aug 1970. Contract AT(04-3)-167. 44p. Dep. CFSTI.

EXPONENTIAL PILES—neutron spectra in STSF-1A, corrections for
—core for STSF-7, configuration of
—criticality calculations for STSF-7
—neutron spectra in STSF-2 and STSF-7
NEUTRON SPECTROMETERS—performance of ORTEC type S2S helium-3, (E)
NEUTRONS, FAST—spectra in fast subcritical assemblies
RADIATION DETECTORS, IONIZATION CHAMBER—performance of proton recoil, (E)
REACTORS, FAST—neutron spectra in, STSF measurements on (D.C.C.)

50186 (ORNL-TM-3159) BULK SHIELDING FACILITY QUARTERLY REPORT: APRIL, MAY, AND JUNE OF 1970. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). 16 Sep 1970. 31p. Dep. CFSTI.

Operations and maintenance requirements during April to June 1970 are described. Tests and research programs are reviewed. (D.C.C.)

50187 (ORNL-TM-3162) HIGH FLUX ISOTOPE REACTOR. Quarterly Report, April–June 1970. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). 24 Sep 1970. 22p. Dep. CFSTI.

Operations and maintenance requirements during April to June 1970 are described. Test programs and experiments are reviewed. Design modifications are listed. (D.C.C.)

50188 SLOWPOKE AND OTHER AECL NEUTRON SOURCES. Can. Res. Develop.; 3: 26-9(Jul-Aug 1970).

SLOWPOKE, which stands for Safe Low Power Critical Experiment, is a small 2 kW reactor which contains 1.5 lb of ^{235}U fuel pins immersed in water and surrounded by a Be reflector. The core is 9 in. in diameter and 10 in. high. A flux of 10 in. n/sec cm^2 of slow neutrons is obtainable. It is regulated by an automatically driven control rod. The water, which is both coolant and moderator, is less effective in the latter function when temperature rises. A sudden surge in energy release from the fuel overheats the water and reduces reactivity automatically to a safe level. Criticality is expected in 1971 or 1972. Uses envisaged are neutron radiography, activation analysis and other purposes requiring a strong neutron source. (F.S.A.)

50189 INVESTIGATION OF THE FISSION PRODUCTS RELEASED FROM THE FUEL ELEMENTS OF THE ZERO POWER REACTOR, ZR-4. Bod, Laszlo; Nemeth, Andras. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem.; 18: 39-54(1970). (In Hungarian).

The calculation method and measuring procedures are described which have been used for the evaluation of the radioactive contamination originating from the fuel elements consisting of a homogeneous mixture of polyethylene and U_3O_8 clad in 0.2 mm pure polyethylene employed in the ZR-4 type zero power reactor. The gamma spectra of the contaminants were measured and some of the radioisotopes were identified. 11 references. (auth)

50190 SPATIAL BEHAVIOR OF THE PENNSYLVANIA STATE TRIGA REACTOR (PSTR) DURING PULSING. Sears, Charles Frederick. University Park, Pa.; Pennsylvania State Univ. (1969). 81p. University Microfilms Order No. 70-7247. Thesis.

The basic objective was to establish whether there is a measurable space dependence in a small reactor core during prompt critical transients and to measure such dependence if it exists. The Pennsylvania State TRIGA Reactor was used as an experimental vehicle to investigate this possible space dependence. Extensive analytical studies have previously been undertaken at the Pennsylvania State University to determine the physical behavior of such a core. These previous studies were used to provide some of the foundations necessary for an analysis of the experimental investigations reported. The water channel neutron flux and the temporal behavior of the fissioning rate in the outer fuel elements of the core were monitored. An out-of-core neutron detector was used as a comparison standard for the other two detectors. This last chamber also provided information on errors which can occur when monitoring fast core transients with an external neutron detector. The signals from the three detectors were intercompared using an on-line analog computer. These comparisons, as well as the detector signals, were displayed on a high speed optical recorder. The six recorder traces were used to study the spatial and temporal behavior of the reactor core and the emitted fission rate information carriers. The pulse traces produced by the in-core neutron detector were used to compute the space independent peak pulse powers and pulse energy releases as measured in each of the four flux holes for four selected reactivity insertions. These measured pulse powers and energy releases were used to look for indications of space dependence during pulses. Differences between the flux profiles for steady state operation and for pulse operation were found. By using the variable heat capacity Fuchs–Nordheim pulse prediction model, the measured peak pulse powers were also used to compute the value of the prompt shutdown coefficient for the PSTR. This coefficient was found to be some fourteen percent lower for pulses of about 200 MW than for pulses of 400 MW or more. The detector intercomparison traces were used to verify the correctness of the hypothesized behavior of the phenomenon sensed by the detectors. Part of the hypothesized behavior was based on the results of the Monte Carlo computer program, TCC. The verification of the hypothesized behavior constituted a verification of a "fine structure" space dependence within a TRIGA fuel cell. The space dependence of individual fuel cells and the similarities of the intercomparison traces for flux holes at various radial locations provided substantial evidence of a small overall space dependence in the fuel fissioning rates of the PSTR. (Diss. Abstr.)

50191 TECHNIQUES IN FAST REACTOR CRITICAL EXPERIMENTS. AN AEC MONOGRAPH. Davey, W. G.; Redman, W. C. Monograph Series on Nuclear Science and Technology. New York; Gordon and Breach, Science Publishers, Inc. (1970). 328p. $16.50. (TID-25527).

The status of the measurement techniques used in fast critical assembly programs is surveyed. Basic fast reactor physics is discussed, and fast critical facilities are described. Nuclear parameters discussed include criticality, the effects of perturbations, reaction rates, reactivity coefficients, reactor kinetics, and neutron spectra. The use of the critical assembly as a reactor design tool is examined. (H.D.R.)

50192 REACTIVITY MEASUREMENTS ON FAST SYSTEMS WITH NATURAL URANIUM METAL BLANKET BY PULSED NEUTRON METHOD. Hiraoka, Toru; Nakano, Masafumi; Nakamura, Tomoo (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 7: 458-65(Sep 1970).

A study has been made on how simple analysis of pulsed neutron experiments could be applied to the measurement of reactivity of fast systems with a blanket of metallic natural uranium. Pulsed neutron experiments have been performed on three fast assemblies of the Fast Critical Assembly at the Japan Atomic Energy Research Institute. The decay constants have been successfully observed even at delayed critical. The energy and spatial higher modes have also been observed. Simple models of Gozani and Simmons–King have been applied to derive the reactivity in dollar units. It has been made clear that the reactivity could be measured by the pulsed neutron method down to −3$, and in a certain case, down to −5$, for fast systems with a core of medium size up to at least about 200 l enclosed in a metallic natural uranium blanket. The establishment of the asymptotic decay has been experimentally investigated. Linearity has been ascertained to hold between the prompt neutron decay constant and the reactivity by the pulsed neutron method and between the reactivities by the pulsed method and by the positive period method down to a few dollars in negative reactivity. 11 references. (auth)

50193 R AND D ACTIVITIES IN O-ARAI ENGINEERING CENTER OF THE POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION. Oyama, Akira; Ichino, Ichiro; Sakata, Hajime; Nakata, Seibe. Nippon Genshiryoku Gakkaishi; 12: 509-23(Sep 1970). (In Japanese).

As part of a Japanese national project for developing the Na-cooled fast breeder reactor and an advanced thermal D_2O-moderated reactor, the Power Reactor and Nuclear Fuel Development Corporation established an engineering research establishment named "O-arai Engineering Center" at O-arai, Ibaraki-ken, Japan. An outline is given of this Engineering Center and the activites undertaken. The Center aims at carrying out such activ-

ities as large scale engineering tests of components and systems to be actually used in the two types of reactors, of such nature as to be beyond the capability of individual industrial organizations of the country, but which are essential for ascertaining the performance of these components and systems, and to acquire the engineering data necessary for design, manufacturing and operation of the reactors. The Center possesses the first Japanese experimental fast reactor "JOYO," Na-technology development facilities, D_2O-moderated reactor engineering facilities, post-irradiation examination facilities, D_2O-moderated critical assembly, and other requisite equipment. An account is given of facilities and equipment. (auth)

50194 INVESTIGATIONS OF LOOP CHANNEL CELLS WITH HIGHLY ENRICHED FUEL ELEMENTS. Klimentov, V. B.; Petrov, N. N.; Nechiporuk, V. A.; Kopchinskii, G. A.; Komarov, O. V. This paper was summarized in At. Energ. (USSR); 25: 46-7(Jul 1968) as paper No. 212. (In Russian).

Test-loop cells intended for thermal reactor investigations are highly heterogeneous, feature a variable neutron energy spectrum, and appreciably steep neutron flux gradients. Results of experimental studies of test-loop cells with fuel elements of highly enriched fuel based on the WWR-M critical assembly are presented. Neutron distributions in the test-loop cells were compared with isolated fuel elements and with assemblies containing three fuel elements, and the effect of water spaces and moderating cavities on thermal flux incident upon the fuel elements was also determined. Models simulating fuel elements in the experiments were rods of 90% enriched UO_2 1.0 cm in diameter and standing 4.0 cm high. The cells investigated were placed in channels 9.8 cm or 11.2 cm in diameter. In the latter case, the fuel elements are placed in graphite sleeves. In the model of a three-element loop channel, the fuel elements were placed at the angles of a regular triangular lattice of 2.2 cm pitch. The neutron distributions were investigated by activation methods, using indium, gold, copper, manganese detectors and ^{235}U foils. Variation factors μ were measured, using ratios of the specific activities of the detectors for any point in the cell and for an asymptotic distribution of neutrons in the core. Results are presented. (auth)

50195 USE OF MOLYBDENUM AND TUNGSTEN FOR DETERMINING FAST NEUTRON FLUXES IN A REACTOR. Ivanov, A. N.; Pravdyuk, N. F. This paper was summarized in At. Energ. (USSR); 25: 516-17(Dec 1968) as paper No. 248. (In Russian).

Calculations show that for a typical reactor neutron energy spectrum the contribution of neutrons of various energies to the total radiation damage is approximately the same for iron, zirconium, molybdenum, and tungsten. This permits one to use the refractory metals tungsten and molybdenum, whose resistivities change very appreciably even at an irradiation temperature of the order of 100°C, to estimate the distribution of fast neutron fluxes (distribution of values of the radiation damage function) in experimental and fueled channels of a reactor core in which the fast neutron flux varies rapidly with distance along a channel. The method was used to estimate the distribution of fast neutron fluxes in fueled and experimental channels of the RTF reactor. (auth)

50196 ANALYSIS OF THE TIME INTERVAL DISTRIBUTION OF NEUTRON PULSES FROM A NUCLEAR REACTOR. Williams, Ronald John. College Station, Tex.; Texas A and M Univ. (1969). 102p. University Microfilms Order No. 70-9731.

Thesis.

Neutron pulses as detected by a BF_3 counter located in the center of an AGN-201 reactor were analyzed concerning their time behavior with the objective of ascertaining the feasibility of an on-line determination of the operating state of the reactor by means of characteristics of the time interval probability density function. The reactor was operated in the delayed critical state and the shutdown state. Operating power was on the order of 10 microwatts or less for all tests. The analyses examined experimentally the truncated autocorrelation function; the sampled, truncated autocorrelation function; and the time intervals between successive pulses. Extensive use was made of visual displays of the functions as they accumulated. Photographs were taken at various record lengths and operating parameters. Experimental support was obtained for the hypothesis that only time intervals in the neighborhood of zero time need to be examined to determine the operating state. The feasibility of an on-line determination of a reactor's state was demonstrated by the means of a deviation from Poisson method. (Diss. Abstr.)

50197 HIGH-SPEED HYDRAULICALLY ACTUATED REACTOR SCRAM CONTROLS. Popov, A. K. This paper was summarized in At. Energ. (USSR); 25: 48(Jul 1968) as paper No. 214. (In Russian).

Stringent requirements are imposed on the dynamics of scram systems for high-output pulsed fast reactors. If the pulse energy is in excess of a set value, the scram system has the job of reducing system reactivity in the time between successive pulses to such an extent as to eliminate any repeated large pulse. These requirements are satisfied by a hydraulically actuated scram system. The advantages of the hydraulically driven system over a gravity-drop scram system after the hold magnets are shut off are investigated. The case where the height and thickness (dimension in the direction from the probe) of a vertically placed reflector for the scram rods are specified so that the reflector weight will be directly proportional to reflector width is considered. Hence, the reactivity change introduced by the scram system in the first stage of rod motion can be considered proportional to the product of the scram reflector weight and its displacement. Results are plotted for a specific reactor core and specific hydraulic drive system at a pulse frequency of 50 pulses/sec. (auth)

50198 DOSE ASSESSMENT FROM THE UA-RR-1 REACTOR CHANNEL. Gamaa, M. A. (Atomic Energy Establishment, Cairo). Health Phys.; 19: 323(Aug 1970).

The dose that would be received by a radiation worker, in case of an accident, from one of the horizontal channels of the UA-RR-1 reactor was assessed using a film badge and the $^{23}Na(n,\gamma)^{24}Na$ reaction. It was assumed that the radiation worker would be 25 cm from the mouth of the channel for 10 min only. These channels are 10 cm in diameter and 330 cm long. The estimated γ-ray dose was found to be 180 ± (10%) rad; that from thermal, intermediate and fast neutrons was 3.5 and 152(±20%) rad respectively. (auth) (UK)

50199 FEASIBILITY STUDIES AND EXPERIMENTS ON A FAST ACTING DRIVE-MECHANISM FOR THE REACTOR SORA SAFETY RODS. Agazzi, A.; Galli de Paratesi, S.; Musik, H. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan); 17: 533-40(Sep 1970).

Studies and experiments are described for a rapid control mechanism based on reflector withdrawal. A survey of some different ways of piloting fast-shutdown pneumatic cylinders is given. As a result of a search of high performance components, completed by suitable bench tests, a full-scale mock-up was erected. Mock-up experiments together with studies on a mathematical model of the system led to the collection of the significant results, which are reported. An analysis of these results shows that a very good dynamic performance, fulfilling the imposed specifications, can be achieved even using non-sophisticated components, so that the design can be realized in a normal and economical way. (auth)

Rocket and Space Reactors

50200 GAS-CORE REACTOR TECHNOLOGY. Clement, J. D.; Williams, J. R. (Georgia Inst. of Tech., Atlanta). Reactor Technol; 13: 226-51(1970).

A gas-core reactor consists of a cavity containing a fissionable gas surrounded by a moderator that is in a critical configuration Fission neutrons from the core are thermalized in the reflector region and in part returned to the cavity. The primary motivation for developing high-temperature gas-core reactors has been for high-specific-impulse, high-thrust nuclear rocket propulsion. There has recently been increasing interest in also using the gas-core reactor for large, highly efficient commercial power plants employing a magnetohydrodynamic (MHD) topping cycle. The two gas-core reactor concepts receiving the most attention are the coaxial-flow (open-cycle) reactor and the vortex-stabilized nuclear light-bulb (closed-cycle) reactor. The coaxial-flow reactor retains the fissile fuel in a critical configuration using a suitable flow scheme, whereas the light-bulb reactor contains the fuel in a regeneratively cooled transparent partition. To develop the technological base necessary for the construction of high-temperature gas-core reactors, investigators are currently carrying out extensive studies in the areas of nuclear analysis, heat-transfer and high-temperature-materials properties, fluid mechanics, and system dynamics, stability, and control of various gas-core reactor configurations. These studies indicate it may be technically feasible to carry out ground tests of full-scale high-temperature gas-core reactors in the near future. 111 references. (auth)

50201 EXPERIMENT ON THE MHD-DRIVEN ROTATING FLOW FOR A GAS-CORE NUCLEAR ROCKET. Love, Wendel L.; Park, Chul (Ames Research Center, Moffett Field, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 1377-85 (Aug 1970).

A fluid dynamic simulation of a gas core nuclear rocket chamber has been made with the objective separating a light and heavy gas

by means of the centrifugal force produced by MHD-driven rotation. The test apparatus, a closed cylinder filled with a mixture of xenon and helium, uses a radial magnetic field configuration with an axial electric current passing between 16 pairs of electrodes. By observing the behavior of the discharge and the luminosity of the gas at different locations, the mode of discharge was found to be stable and suitable for effective separation. A rotating flow with transonic Mach number was produced as evidenced by the ratio (>2) of the pressure at the wall of the cylinder to that at the center. Spectroscopic measurements of the plasma condition show an appreciable degree of separation of the two species. The Hall parameter was found to be less than one. 16 references. (auth)

50202 GAS CORE NUCLEAR ROCKETS. McLafferty, George H. (United Aircraft Research Labs., East Hartford, Conn.). Nucl. News; 13: No. 10, 48-54(Oct 1970).

The development programs for gas core nuclear rockets are reviewed. The coaxial-flow reactor and the light bulb reactor concepts are compared. 29 references. (D.C.C.)

50203 ADVANCED NUCLEAR ROCKET TECHNOLOGY. Kirk, William L. (Los Alamos Scientific Lab., N. Mex.). Nucl. News; 13: No. 10, 46-8(Oct 1970).

Research and development activities on the Rover Reactors are reviewed. Potential improvements in the features of solid core reactor engines are described. (D.C.C.)

50204 NUCLEAR ROCKET APPLICATIONS IN THE POST-APOLLO ERA. Gronich, S. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). Nucl. News; 13: No. 10, 39-45(Oct 1970).

The development programs in the U. S. for nuclear rocket propulsion are reviewed. Performance, mission requirements, and development approaches are presented for the two alternate mission modes: nuclear flight propulsion module; and reusable nuclear shuttle. 14 references. (D.C.C.)

Process Heat and Desalination Reactors

50205 (ORNL-NDIC-7) INDEXED BIBLIOGRAPHY OF NUCLEAR DESALINATION LITERATURE-5. Johnsson, K. O. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 59p. Dep. CFSTI.

Abstracts are given for approximately 210 published articles related to the desalination of seawater. The body of the report is a copy of information stored in a computerized storage and retrieval system for the Nuclear Desalination Information Center (NDIC) at the Oak Ridge National Laboratory. The abstracts are grouped in nine categories (and repeated if they fall into more than one category). An author and a keyword index to the articles referenced is provided. The keywords, which identify the content of the articles, were chosen from a thesaurus developed by NDIC. (auth)

50206 NUCLEAR POWERED SEA WATER DESALINATION PLANT. Baranowski, K.; Lukacs, G.; Rossberg, K.-E.; Schafstall, H.-G. (Fried-Krupp, Essen). Tech. Mitt. Krupp, Werksber.; 28: 41-8(Jul 1970). (In German).

The use of a desalination plant in combination with different types of nuclear reactors built or planned in West Germany is investigated and the different combinations are compared. For a dual-purpose installation producing water and power, the back-pressure principle was assumed and for the desalination section the multi-stage flash evaporation principle. Dual-purpose plants with water reactors involve the lowest cost for the future demand anticipated in different regions on the basis of a market survey. High-temperature reactors as sources of energy for desalination plants are particularly suitable in areas of heavy demand. (9 references) (auth)

Reactor Theory

Refer also to abstract 50147.

50207 OPTIMAL CONTROL OF NUCLEAR REACTORS. Mohler, Ronald R.; Shen, C. N. Nuclear Science and Technology, A Series of Monographs and Textbooks. New York; Academic Press Inc. (1970). 338p. $16.50.

Optimal control techniques and their application to specific problems of reactor design and control are summarized. Calculations of optimal control trajectories for minimum-time, minimum-poison, minimum-stress, and minimum-error processes for various nuclear systems are presented. The use of quasilinearization, a new computational algorithm, for the optimal design of practical process-control systems is described. (H.D.R.)

50208 CHOICE OF A HEAT-CARRIER TEMPERATURE-VARIATION PROGRAM. Volik, B. G.; Dolginova, N. A. This paper was summarized in At. Energ. (USSR); 25: 137-8(Aug 1968) as paper No. 220. (In Russian).

In planning highly-maneuverable reactor control systems it is essential to know the program of the fastest change in the temperature of the heat carrier at the same time guaranteeing reliable operation of the technological equipment (from the point of view of mechanical strength). For cylindrical constructions with their inner walls in contact with the heat carrier and their outer walls thermally insulated, a program of this kind is derived with the condition that the thermal stresses at the most dangerous point (at the inner wall) should vary exponentially. (auth)

50209 CALCULATION OF THE EFFECTIVE BOUNDARY CONDITIONS FOR MULTILAYER BLOCKS. Lobyntsev, V. A. This paper was summarized in At. Energ. (USSR); 25: 138(Aug 1968) as paper No. 221. (In Russian).

A method of determining the effective boundary conditions on a block surface required for finding the neutron distribution in a moderator is considered. The problem is of the one-velocity type, and the angular distribution of the neutrons is taken in the P_1 approximation. There is no scattering in the block, but the absorption cross-section may depend on the coordinates. Expressions are obtained for the logarithmic derivative of the neutron flux at the boundaries of the media, for the block self-screening coefficient, and for the distribution of neutron flux in the block. (auth)

50210 RECONSTRUCTION OF A FAST NEUTRON REACTOR SPECTRUM FROM THRESHOLD DETECTOR DATA. Chernoyarskii, A. A.; Medik, V. S.; Zaitov, A. M.; Kukhtevich, V. I. This paper was summarized in At. Energ. (USSR); 26: 371-2(Apr 1969) as paper No. 276. (In Russian).

An improvement in Dierckx's method for reconstructing a fast neutron spectrum in the 1 to 3 MeV range by using the exponential approximation is presented. Computer calculations were made of functions of the exponential approximation parameters. The calculations used the actual energy dependence of the cross sections. The functions were calculated for values of the exponent from 0 to 2.4 which enables one to reconstruct all possible neutron spectra occurring in actual reactor cores. In each energy interval the point closest to the true spectrum is found. Analysis shows that this point is most stable with respect to errors in the activation integrals. As a result of studying several sets of threshold detectors it was established that the set ^{237}Np (n,f), ^{238}U (n,f), ^{27}Al (n,p), ^{56}Fe (n,p), and ^{27}Al (n,α) yields a very stable solution with respect to errors in the experimental data. The inclusion of ^{237}Np (n,f) and ^{238}U (n,f) permits the low-energy limit of the reconstructed spectrum to be extended to 0.5 MeV. This method was used to reconstruct the spectra of two different reactors which had been reconstructed by other methods. Satisfactory agreement of the results shows that the proposed method may be very successfully used to reconstruct fast neutron reactor spectra by using a small number of detectors. (auth)

Kinetics

Refer also to abstracts 49686 and 50255.

50211 (BARC-492) PARTIAL DIFFERENTIAL OPERATOR AND ITS APPLICATIONS. Trasi, M. S. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 25p. Dep. CFSTI (U. S. Sales Only).

The properties of the partial differential operator and its inverse are examined, and it is shown how they can be used in the integration of inhomogeneous first order partial differential equations: the analogy with the total differential operator is pointed out, and a geometrical interpretation is given. It is also shown that the boundary condition has to satisfy a certain consistency condition. As an application the theory is applied to the solution of a heat convection problem in a circulating fuel reactor. The theory is first developed for the two-variable operator, then extended to the case of the three variable operator and finally to the case of the n-variable operator. (auth)

50212 (BARC-493) NONLINEAR STABILITY ANALYSIS IN REACTOR THEORY. Trasi, M. S. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 55p. Dep. CFSTI (U. S. Sales Only).

A review is made of the methods used in the prediction of nonlinear stability in simple reactor systems. Some preliminary

concepts and theorems are introduced; the principle underlying Liapunov's first method, its applications and limitations are then explained; these are finally followed by a discussion on Liapunov's second method and some applications. An elementary introduction to non-linear dynamics is included. (11 references) (auth)

50213 (BNWL-1433) BMC-I: THE BATTELLE MONTE CARLO CODE. Thomsen, D. H.; Traver, T. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 147p. Dep. CFSTI.

The Battelle Monte Carlo code (BMC) is a general purpose neutronic Monte Carlo code written in Fortran-S for use on the UNIVAC-1108 computer. The code was developed primarily for use in solving some of the more complex problems encountered in predicting the neutronic characteristics of thermal reactors. It is flexible as to the size and type of problem to be solved and in the cross section and geometry detail which may be used. The neutron fluxes and reaction rates in the energy range from 0 to 10 MeV are calculated in one, two or three space dimensions. Statistical confidence limits are assigned to the results. The cross sections utilized in the BMC code are processed from data in the ENDF/B format. (9 references) (auth)

50214 (IN-1416) CORA: A FEW GROUP DIFFUSION THEORY CODE FOR ONE-DIMENSIONAL REACTOR ANALYSIS. Anderson, E. C.; Putnam, G. E. (Idaho Nuclear Corp., Idaho Falls). Aug 1970. Contract AT(10-1)-1230. 122p. Dep. CFSTI.

The CORA few group (four), one-dimensional neutron diffusion program is written in Fortran 4 and is currently operating on IBM 360 Series machines with a requirement for 250 K of core storage. The program solves for either the direct flux or adjoint solution in slab, cylindrical, or spherical geometry. It uses the standard Gaussian elimination and backsolution methods for solving the difference equations for the mesh point fluxes in each group and it uses the usual power method or source iteration method with optional Chebyshev acceleration to solve eigenvalue problems. The program allows: very general boundary conditions (with sources); all the usual buckling, poison, region dimension, and boundary searches as well as a special total fission source search that allows quick solution of fixed source problems in reactors near critical; very general fixed volume sources (group and space dependent); and edits of peak-to-average ratios of important quantities, neutron balances by group and region, and currents and leakages at region boundaries. The program can perform perpendicular direction buckling iteration to find consistent sets of bucklings for up to three directions. The package includes a very flexible flux-adjoint weighting program and a plot program for graphical output. (auth)

50215 (NP-18281) IRESINT: A COMPUTER PROGRAM TO CALCULATE RESONANCE INTEGRALS. Report No. 506/69. Wasastjerna, Frej (Technical Univ. of Helsinki, Otaniemi (Finland). Dept. of Technical Physics). [ndl. 80p. Dep. CFSTI (U. S. Sales Only).

The IBM S/360 Fortran IV G program IRESINT is described. This program computes heterogeneous resonance integrals for both fissile and non-fissile nuclides, and for resolved and unresolved resonances. The resolved resonances are computed according to the intermediate resonance approximation. The geometry has to be a regular square or hexagonal lattice of cylindrical fuel rods. (12 references) (auth)

50216 (PEL-198) EQUATIONS FOR THE COMPUTER COMPUTATION OF THE KINETIC ENERGY DISTRIBUTIONS OF FISSION FRAGMENTS RELEASED FROM NUCLEAR FUEL SURFACES BY RECOIL. Van Reenen, T. J.; De Wet, W. J. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Mar 1970. 7p. Dep. CFSTI (U. S. Sales Only).

Equations for the computer computation of the kinetic energy distributions of fission fragments released from nuclear fuel surfaces by recoil have been derived. The kinetic energy distributions of single fission fragment mass lines, as well as the global kinetic energy distribution, incorporating all mass lines, can be evaluated. Final equations are given for "thick" fuel sources. These were applied to U and UO_2 sources for which the results are presented graphically. (20 references) (auth)

50217 (RISO-M-1257) MONTE CARLO SUPERPOSITION CALCULATIONS OF RESONANCE INTEGRALS IN A REACTOR CELL. Kirkegaard, Peter (Danish Atomic Energy Commission, Risoe, Research Establishment). Jul 1970. 56p. Dep. CFSTI (U. S. Sales Only).

A description is given of a computer program, AEK P-598 MCSUP, which calculates the resonance intergral for a single resonance in a square reactor lattice cell, containing a cylindrical fuel zone surrounded by a moderator zone. The fuel zone contains only one nuclide type, while the moderator may be composed by several nuclide types. Scattering interference and Doppler broadening is included. MCSUP is a Monte Carlo code based on the super-position method devised by Spanier and Gelbard. The code is well-suited for calculations on isolated fuel rods. It is written in FORTRAN IV. 24 references. (auth)

50218 (RISO-M-1289) INTEGRAL TRANSPORT THEORY IN VARIOUS GEOMETRIES. Neitrup, H. (Danish Atomic Energy Commission, Risoe, Research Establishment). Aug 1970. 16p. Dep. CFSTI (U. S. Sales Only).

The main equation of integral transport theory in multigroup version is discussed. The calculation of the collision matrix in annular symmetric clusters by numerical integration in a modified CLUCOP scheme is described. An approximate method for obtaining the same results is given in details and comparison between some results from this method and the original CLUCOP-programme is given. A short discussion of the construction of source terms and transport corrected cross sections is also given. (auth)

50219 NEUTRON PULSE PROPAGATION IN MULTIPLYING ASSEMBLIES. Golay, Michael Warren. Ithaca, N. Y.; Cornell Univ. (1969). 226p.

Thesis.

The dependence of the kinetic behavior of a nuclear reactor upon the reactivity of the assembly is investigated by studying neutron pulse propagation in a series of similar cores of the Cornell Critical Facility (Zero Power Reactor). Neutron pulse propagation experiments were conducted by injecting one end (of the various assemblies) with bursts of 14.3 MeV neutrons. The axial dependence of the response of each reactor was mapped using a multiscaling neutron detection system. The data from neutron pulse propagation experiments conducted in these assemblies are analyzed in the time and Fourier/Laplace transform domains. In each assembly the time-domain behavior is compared with that predicted by a synthesis of exponentially decaying transverse and axial modes. It is found that the measurements and predictions agree well at long times, but poorly at short times. This is mainly due to the use of only four modes in the synthesis. The short time reactor response is accurately represented by the behavior of an equivalent reactor of infinite length. (Diss. Abstr.)

50220 SOURCE-TRANSIENT REGION OF NEUTRON WAVES IN MULTIPLYING SYSTEMS. Matsumoto, Takaaki (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 474-6(Sep 1970).

A recent development in reactor physics has been the application of the neutron-wave propagation technique to multiplying systems, and determination of "dispersion laws" for neutron waves in several systems. The dispersion law in a system is usually obtained from measurements in an asymptotic region far away from the source and from the surfaces. The asymptotic energy spectrum in a multiplying system is generally different from the thermal spectrum of the source, and thus the source-transient region will occupy a fairly wide region in the system. A study of the source-transient region for obtaining exact dispersion laws in multiplying systems is presented. (auth)

50221 INVARIANT-IMBEDDING APPROACH TO REACTOR PHYSICS CALCULATIONS. Hanson, John Nils. Pittsburgh; Carnegie-Mellon Univ. (1969). 152p. University Microfilms Order No. 70-7329.

Thesis.

A method has been developed for calculating local activation rates directly from the invariant imbedding method. The development is carried out first for a one-energy group rod model, then for a multigroup rod model, and finally extended to the one-dimensional multigroup slab. The method consists of calculating the multiple reflection of transmission and escape functions at absorption interval boundaries; and then performing a source balance due to leakage, scattering in, and internal sources on the absorption interval. The multiple collisions of the particles accounted for in the source balance lead to the absorptions in the interval. The result is the direct calculation of local multigroup absorption rates from the invariant imbedding functions. The one-dimensional slab invariant imbedding equations are developed in a discrete ordinate form including anisotropic scattering. The whole method is then cast in matrix notation. Several potential applications of the method are discussed including the possible advantages over conventional methods. An application of the method was programmed for the Univac 1108 computer. The program, called SLAB II, performs a power method, multiplication calculation for multiregion, multigroup, one-dimensional slab reactor systems resulting in local absorption rates, system and interval region leakages, and system multiplication factors. Calculations were performed using SLAB II for four reactor systems including seed-

blanket systems, a lattice cell system, and a thermal system containing up-scattering. The same systems were calculated using a conventional S_N method. Comparisons are made between local and integral calculation results, and illustrations of the characteristic functions of both methods are included. (Diss. Abstr.)

50222 CELL CALCULATIONS IN THE ASYMPTOTIC P_N-APPROXIMATION. Shulepin, V. S. This paper was summarized in At. Energ. (USSR); 24: 378(Apr 1968) as paper No. 196. (In Russian).

It was proposed to use the asymptotic P_N-approximation and the continuity requirement for unidirectional currents at media boundaries. The results of numerical calculations of the critical size of a reflected slab reactor show that the P_{A2}- and P_{A3}-approximations give good accuracy. However the accuracy of the P_{A2}- and P_{A3}-approximations turns out to be inadequate for two-dimensional calculations in a close-packed lattice. The accuracy of the asymptotic P_N-approximation may be improved by replacing the conditions for the continuity of unidirectional currents by redefined conditions at the boundary between the k-th and (k + 1)-th regions of the cell. The results of a two-dimensional two-region cell calculation are presented. It is shown that the asymptotic P_3-approximation with redefined conditions gives high accuracy. The cell calculation can take account of anisotropic scattering within the framework of the asymptotic P_N-approximation. This approximation with redefined conditions may be extended to the case of two-dimensional geometry; if N is not very large it is about as time-consuming as the P_1-approximation. 5 references. (auth)

50223 COUPLING EFFECTS IN FAST REACTORS USING THE MONTE CARLO TECHNIQUE. Flanagan, George Fergus. Ames, Iowa; Iowa State Univ. (1969). 74p. University Microfilms Order No. 70-7696.

Thesis.

The basic definitions of a coupling model are used to calculate the normalized coupling coefficients in a bare two-slab fast reactor. The calculations are performed using the O5R Monte Carlo code. The Monte Carlo technique follows a neutron through the assembly from its release until it is absorbed or escapes. The neutron path length between interactions and the type of interaction (fission, capture, or scattering) which it undergoes are determined by the materials, neutron cross sections, and angular distributions for various reactions. Since the origin and destination of each neutron are known using Monte Carlo, this technique readily permits the statistical prediction of coupling coefficients. Inelastic scattering is handled using the evaporation model. Anisotropic scattering is treated using the Coveyou technique. This technique gives the same accuracy as a fourteen-term Legendre expansion, but it requires considerably less computer time. The run times for the calculation are on the order of three minutes or less with standard deviations of less than two percent. The coupling coefficients are found to remain constant for systems with criticalities ranging from 0.875 to 1.138 provided the geometrical arrangement is not changed. This phenomenon does not appear to be unique to a particular geometrical arrangement over the range of variables investigated. (Diss. Abstr.)

50224 SPACE DEPENDENCE OF THE REACTOR KINETIC PARAMETER AS MEASURED BY THE GARELIS-RUSSELL METHOD. Laperches, C.; Munno, F. J. (Univ. of Maryland, College Park). Nucl. Sci. Eng.; 42: 93-7(Oct 1970).

It is shown that the (β/Λ) parameter is space and pulse width dependent when β/Λ is mode dependent and when the pulse width is finite. A method is presented for the determination of β/Λ from the Garelis–Russell technique. The model used is a two-group diffusion, bare core model where the time-shape of the neutron source is represented by a series of rectangular pulses. (auth)

50225 FORMULATION OF CONTINUOUS SLOWING DOWN THEORY FOR GENERAL PROCESSES IN TERMS OF SEPARABLE KERNELS. Becker, Martin; Burns, Edward T. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-1)-328. Nucl. Sci. Eng.; 42: 100-3(Oct 1970).

A better theoretical base is developed for the implementation of the equations of continuous slowing down theory in situations where slowing down processes other than elastic scattering take place. (auth)

50226 DISCRETE SPECTRUM OF THE TRANSPORT OPERATOR. Silvennoinen, Pekka; Zweifel, P. F. (Virginia Polytechnic Inst., Blacksburg). Nucl. Sci. Eng.; 42: 103-4 (Oct 1970).

One of the most effective techniques for the solution of the transport equation is to employ the full-range orthogonality properties of the singular eigenfunctions. This technique is applicable only if the eigenvalue spectra of the appropriate Boltzmann operator and the adjoint operator are identical. It is shown that this is the case for a rather general anisotropic scattering kernel. (auth)

50227 NONLINEAR OSCILLATIONS AND STABILITY OF A NUCLEAR REACTOR WITH TWO REACTIVITY FEEDBACKS. Schmidt, Theodore R. (Sandia Labs., Albuquerque, N. Mex.); Hetrick, David L. Nucl. Sci. Eng.; 42: 1-9(Oct 1970).

The space-independent reactor kinetics equations with two reactivity feedbacks are analyzed for stability and nonlinear oscillations. Expressions are derived using Fourier series methods for determining the frequency and fundamental amplitudes of the oscillations in reactivity and power. These results are compared with exact solutions of the system equations and agree in all cases for equilibrium power levels near the critical power level. The system of equations is examined for the effect of delayed neutrons on oscillatory solutions. When delayed neutrons are included, unstable limit cycles are found as well as stable limit cycles. (auth)

50228 EFFECT OF DELAYED NEUTRONS ON AUTONOMOUS NONLINEAR POWER OSCILLATIONS. Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.); Hetrick, David L.; Schmidt, Theodore R. Nucl. Sci. Eng.; 42: 10-15(Oct 1970).

In a reactor with feedback linearly proportional to the power level, the delayed neutrons permit the existence of unstable limit cycles. This means that, for linearly stable systems, the delayed neutrons can cause the system to become unstable for large enough disturbances. This is demonstrated analytically when the frequency of the limit cycle is near to the linear critical frequency. General criteria, based on the feedback transfer function, are given for the necessary existence of periodic solutions. Techniques for determining the stability of these periodic solutions are then shown. Examples are given for several reactor models. (auth)

50229 IMPROVED COLLISION PROBABILITY METHOD FOR THERMAL-NEUTRON-FLUX CALCULATION IN A CYLINDRICAL REACTOR CELL. Bosevski, T. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Nucl. Sci. Eng.; 42: 23-7(Oct 1970).

An improved collision probability method for thermal-neutron-flux calculation in a cylindrical reactor cell has been developed. Expanding the neutron flux and source into a series of even powers of the radius, one gets a convenient method for integration of the one-energy group integral transport equation. It is shown that it is possible to perform an analytical integration in the x-y plane in one variable and to use the effective Gaussian integration over another one. Choosing a convenient distribution of space points in fuel and moderator the transport matrix calculation and cell reaction rate integration were condensed. On the basis of the proposed method, the computer program DISKRET for the ZUSE-Z 23 K computer has been written. The suitability of the proposed method for the calculation of the thermal-neutron-flux distribution in a reactor cell can bee seen from the test results obtained. Compared with the other collision probability methods, the proposed treatment excels with a mathematical simplicity and a faster convergence. (auth)

50230 CONSIDERATION OF NONMODERATING COLLISIONS IN TUBES FOR RESONANCE ABSORPTION. Henssen, H. (INTERATOM, Bensberg, Ger.). Atomwirth., Atomtech.; 15: 399-400(Aug 1970). (In German).

An approximation equation is developed for calculating the effects of non-moderating neutron collisions on the resonance integral. The equation is based on the assumption that the tube wall represents a thin layer between moderator and resonance absorber. Each neutron traveling from moderator to absorber experiences a non-moderating collision within the range of a certain probability. Some of the neutrons will be scattered back into the moderator. If the tube wall thickness is small in comparison with its curvature, an equal probability for backscatter exists for the absorber region. (H.B.G.)

Dynamics

Refer also to abstracts 50088 and 50092.

50231 XENON-INDUCED SPATIAL POWER OSCILLATIONS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Reactor Technol; 13: 252-79(1970).

Studies on xenon-induced spatial power oscillations in reactors are presented under the following subject headings: stability analyses; digital and analog computer simulation methods; experiments; verification of analytical methods; analytical studies; and methods and theory of control. 84 references. (D.C.C.)

50232 INVERSE SOLUTION OF THE HEAT TRANSFER EQUATIONS FOR A TWO-COMPONENT NUCLEAR REACTOR.

Brikker, I. N.; Astaf'ev, V. P.; Mirzoyan, A. R. This paper was summarized in At. Energ. (USSR); 24: 372(Apr 1968) as paper No. 191. (In Russian).

Presented are an analytic expression for the time dependence of the neutron density which will ensure that the coolant temperature at the reactor outlet will vary according to some prescribed law, and an equation determining the change in the effect of temperature on reactivity. The functionals allow one: (1) to determine how the heat generation must change to ensure a prescribed variation of coolant temperature at the reactor outlet; for example, a failure in a multiloop system requires the shutdown of certain loops; (2) to find how the control component of reactivity must change with time to produce a prescribed time behavior of the heat generation; (3) to solve most effectively the problem of designing an automatic control system to maintain a prescribed time dependence of the coolant temperature at the reactor outlet. (auth)

50233 ACOUSTIC INSTABILITY IN A NUCLEAR REACTOR. Goryachenko, V. D. This paper was summarized in At. Energ. (USSR); 24: 376(Apr 1968) as paper No. 197. (In Russian).

The conditions for exciting acoustic instabilities in a reactor using a gas fuel are studied. Acoustic instabilities can arise because of the compressibility of the fuel and the dependence of heat-liberation upon the density of the fissioning material. An analysis of stability is performed using two different mathematical models. In the first model (with lumped parameters) the concept of an acoustic resonator is used while in the second model (with distributed parameters) an approximate description is given of uniform gas instabilities. A specific analysis of stability using both models was done using the method of D-partitioning of the plane of two real parameters, one of which characterizes the density coefficient of reactivity and the other the friction in the system. It was explained that both models are equally applicable for acoustic-instability analysis. It is shown that the main effect on acoustic instability comes from three reactor parameters: the density coefficient of reactivity, the steady-state thermal power of the equipment, and the friction in the system (drag). An increase in the first two parameters decreases the stability reserve and can cause acoustic instabilities to form. An increase in the third parameter aids in reactor stability. Moreover, it is established that in a reactor using a gas fuel acoustic instabilities are possible when the power does not change if the friction is sufficiently weak and the steady-state power is fairly high. It was also shown that the reactor can operate stably even for a negative (but sufficiently small in magnitude) density coefficient of reactivity. Both the last two factors are due directly to the dependence of energy liberation upon the fuel density. (auth)

50234 SPACE–TIME EFFECTS IN FAST REACTOR DYNAMICS. Jackson, James Fredrick. Los Angeles; Univ. of California (1969). 285p. University Microfilms Order No. 70-8253.

Thesis.

A numerical investigation of space-time effects in the dynamic behavior of large, liquid metal cooled, fast breeder reactors is presented. The basic approach was to compare results from point kinetics and time-dependent diffusion theory. The accuracy of point kinetics was determined for different approximations to the shape function used in calculating the reactivity and feedback coefficients. Several space-dependent feedback models were implemented and studied. Transients without feedback were examined to isolate the spatial effects associated with the initiating perturbation. The amount of spatial flux tilting that could be expected from localized reactivity insertions was determined as a function of reactor size, as well as magnitude and location of the initiating perturbation. Ramp reactivity insertions from $2/sec to $50/sec were studied. Although conventional point kinetics based on the unperturbed flux shape gave the expected poor results, approximating the shape function by the perturbed flux shape at prompt-critical was shown to give greatly improved accuracy. In general, it was found that spatially uniform feedback does not significantly complicate the application of point kinetics. Feedback with strong space-dependence can lead to serious errors. Transient response in the presence of a central region of positive feedback (but with initial overall negative feedback) was extensively studied. The situation of a uniform prompt negative fuel temperature feedback in conjunction with a delayed, locally positive, space-dependent coolant feedback was also investigated. The space dependence of the coolant feedback does not appear to be a problem at normal coolant flow rates. For relatively long period transients at reduced flow conditions, however, strong positive feedback in the central region can again induce spatial effects that can influence the transient behavior. (Diss. Abstr.)

50235 STABILITY OF RELAY SYSTEMS FOR THE AUTOMATIC START-UP OF NUCLEAR REACTORS. Solov'ev, M. M. This paper was summarized in At. Energ. (USSR); 24: 256-7 (Mar 1968) as paper No. 184. (In Russian).

The stability of relay systems for automatic reactor startup with respect to the reciprocal of the starting period is investigated. The method used is the D-decomposition of the harmonically linearized system and separation of the stable regions of the runaway reactor in the plane of the two parameters: the amplification factor K and the time constant T_f of the filter in the circuit for measuring the reciprocal of the starting period. The effects of the kinetic equation parameters for the runaway reactor and the way in which the kinetic equation is approximated on the stability of the reactor start-up processes are analyzed. The results can also be extended to continuous automatic startup systems with respect to the reciprocal of the startup period. 4 references. (auth)

50236 CALCULATION OF TRANSIENT CONDITIONS OF A STEAM GENERATOR BY MEANS OF A DIGITAL COMPUTER. Leonchuk, M. P. This paper was summarized in At. Energ. (USSR); 24: 564(Jun 1968) as paper No. 206. (In Russian).

Economical ways of calculating the dynamics of nuclear reactors by means of digital computers are studied. The dynamics of a steam generator are analyzed. The dependence of the coolant parameters on pressure and enthalpy is considered. An integral model of momentum and the dependence of the parameters of the medium on enthalpy only are studied. To solve this problem on a digital computer, a plain finite-difference scheme was used which involves a step width limited in time and requires much machine time to calculate the dynamics. Hence, such an approach is not economical and sets a limit to the possibilities of using a digital computer. The accuracy of various finite-step schemes for solving the heat transfer equation is analyzed. Polynomial approximations, the coefficients of which are determined by the least-squares method, are used to describe the dependence of temperature and specific gravity on enthalpy and pressure. The recursion method for solving the unsteady heat conduction equations is extended to a three-point approximation of third-kind boundary conditions. 12 references. (auth)

50237 EFFECT OF A CHANGE IN DENSITY OF FISSIONABLE MATERIAL ON THE STABILITY OF A CIRCULATING FUEL REACTOR. Goryachenko, V. D.; Denisov, V. A.; Trunin, Yu. F. This paper was summarized in At. Energ. (USSR); 24: 378(Apr 1968) as papér No. 199. (In Russian).

The stability of steady-state operation of a circulating fuel power reactor has been investigated. The dependence of fuel density on enthalpy is considered. The mathematical model of the dynamics consists of a set of nonlinear partial differential equations. Stability was studied by using linearized dynamic equation for small initial perturbations of steady-state operation. The dependence of fuel density on its enthalpy is an unstabilizing factor which decreases the size of the stable region. (auth)

Experimental Applications

50238 (JUL-652-RG) DETERMINATION OF THE FAST FISSION FACTORS OF BERYLLIUM AND BERYLLIUM OXIDE BY THE METHOD OF A PULSED NEUTRON SOURCE. Demmeler, Martin (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Apr 1970. 98p. (In German). Dep. CFSTI (U. S. Sales Only).

Measurements were carried out to test the previously published results for the fast fission factor of BeO averaged on the U fission spectrum with the use of a new method. In a determination of the utility of the method Be metal was used. The measurement results show a good agreement within the range of measurement accuracy with the results of other studies and yields a contribution to the confirmation of the measurement results obtained by Haefele, Krasin, and Rief for Be metal and Haefele, Kirch, and Rief for BeO. This method was shown usable for the proof of the increase of the intensity and lifetime of thermal neutron fields in relatively small scattering media. For special cases with spherical geometry the corresponding solutions could be given. The program presented could be applied in modified form to the determination of the reflector influence on the dynamics of reactors. No difficulties exist in the measurement principle where the presence of an isotropic purely thermal neutron field represents an hypothesis essential for the measurement process. Additional applications of the two-zone method to the study of reactor parameters are suggested. (tr-auth)

50239 (NP-18366) INTEGRAL METHODS FOR EXPERIMENTAL DETERMINATION OF ν_{eff} IN REACTORS WITH HARD NEUTRON SPECTRUMS. Mogil'ner, A. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk.

Fiziko-Energeticheskii Institut). 1968. 7p. Dep. CFSTI (U. S. Sales Only).

An experimental method for determination of ν_{eff} without using any calculation constants except for a correction factor for the specially selected assemblies is developed. This allows the method of statistical weights to be successively used for precision integral measurements of the values of ν_{eff} in other assemblies with a hard neutron spectrum. The method can also be used in thermal reactors for measurement of other coefficients included in the formula of the four co-factors (for example, for determination of the resonance absorption coefficient). The integral nature of the method of statistical weights allows very high accuracy to be achieved if experiments are carefully performed. (auth)

50240 SENSITIVITY OF NUCLEAR REACTOR BOILING DETECTION BY NEUTRON FLUX NOISE AND ACOUSTIC METHODS. Foster, Robert Gilmer Jr. Raleigh, N. C.; North Carolina State Univ. (1969). 159p. University Microfilms Order No. 70-9165.

Thesis.

The sensitivity of boiling detection in nuclear reactors under ideal conditions by neutron flux noise and acoustic methods is studied. Boiling is created by an electrical heater in the center of the North Carolina State University Reactor. Both analog-filter and digital auto- and cross-correlation techniques are used for neutron flux noise analysis. Acoustic noise analysis is performed both spectrally and with a wide band method using a hydrophone in the reactor tank. The reactivity oscillator is used for a calibration standard for the neutron flux noise analysis. With a heat flux of 124 watts/cm^2, an amount of boiling void not greater than 0.4 cm^3 was produced. This amount of boiling was not detected by neutron flux noise analysis but was easily detected acoustically. From the neutron flux noise and acoustic measurements, the acoustic method of boiling detection was estimated to be at least 52,000 times more sensitive than the neutron flux noise method of boiling detection under ideal conditions. (Diss. Abstr.)

50241 DECAY TIME OF THE HIGHER HARMONICS AS WELL AS THE INFLUENCE OF A CONSTANT NEUTRON SOURCE ON MEASURING TIME AND ERRORS IN THE ROSSI ALPHA EXPERIMENTS. Lickteig, K. (Technische Univ., Berlin). Atomwirth., Atomtech.; 15: 400-2(Aug 1970). (In German).

With the zero power reactor SUR 100 BE, it was shown that determination of alpha is possible without the influence of higher harmonics, a dependence on location, or the effect of delayed neutrons. Rossi alpha experiments close to the delayed critical condition are meaningful only with a special neutron source. As measuring procedures, the cross-correlation experiment B → A was found to be superior to the auto-correlation experiment A → A. With the measuring procedure B ↓ → A, no improvement could be achieved in comparison to the procedure B → A. (H.B.G.)

50242 DETERMINATION OF THE CALIBRATION FACTOR P(t) FROM ABSOLUTE DATA. Rustichelli, F. (CCR-EURATOM, Ispra, Italy). J. Nucl. Energy; 24: 237-43(Sep 1970).

A method is proposed for the determination of the calibration factor P(t), used in fast fission ratio measurements. The method is based on the utilization of absolute data for the fast fission ratio δ^{28} in single rod. An experimental value of P(t), obtained by irradiating a single rod according to the present technique, is in agreement, inside the experimental errors, with the classical method utilizing a back-to-back fission chamber. (auth) (UK)

50243 COMPARISON BETWEEN CALCULATIONS AND EXPERIMENTS IN A MICROLATTICE WITH EUROPIUM SIMULATING PLUTONIUM. Gibello, A.; Moioli, P.; Orestano, F. V.; Pistella, F. (Comitato Nazionale per l'Energia Nucleare, Rome). J. Nucl. Energy; 24: 253-60(Sep 1970).

The reliability of calculation methods for the neutron design of fuel elements, in the presence of thermal resonance absorption, was tested for different lattice patterns analogous to actual patterns in power reactors (uniform lattice and pin clusters surrounded by water gaps). The calculated results were compared with the results of gamma-scanning measurements, for a microlattice containing europium as thermal resonance absorber mocking-up plutonium. (auth) (UK)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 48354, 48859, 48863, 48870, 48874, 48876, 48884, 48889, 48909, and 49981.

50244 (IN-1427) SLOW NEUTRON INELASTIC SCATTERING PROGRAM AT THE MTR (1956-1970). (Idaho Nuclear Corp., Idaho Falls). Sep 1970. 40p. Dep. CFSTI.

The Inelastic Scattering Program at the MTR is reviewed. The product of the program is data describing how thermal neutrons are scattered and moderated by materials. The comparison of experimental and theoretical data is presented. 152 references. (D.C.C.)

50245 (KFK-1163) PRESSURE-EQUALIZING CLOSURE FOR REACTOR FUEL ELEMENTS WITH LIQUID SEAL AND POROUS BODIES. Reiss, F. E.; Dorner, S. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Mar 1970. 21p. (In German). Dep. CFSTI (U. S. Sales Only).

The stable configurations of liquids in porous media are analyzed. A new concept is presented for a pressure release valve for reactor fuel elements which utilizes a wetting or a nonwetting liquid on both sides of a porous disc. The operation of this valve is discussed and its properties are compared with those of the known simple porosity-based valve and those of the pure hydrostatic valve. The new device shows some advantages over known concepts. 11 references. (auth)

50246 (ORNL-4601) EVALUATING FUEL BEHAVIOR DURING IRRADIATION BY FISSION-GAS RELEASE. Carroll, R. M.; Sisman, O. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 30p. Dep. CFSTI.

If a nuclear fuel is being irradiated where evolved fission gas can be measured, considerable information about the physical condition of the fuel can be obtained from observations of how the fission-gas release rate responds to different irradiation conditions of the fuel. The unchanging release of fission gas as burnup progresses can assure the experimenter that the fuel has not changed physical characteristics. Alternatively, a variable behavior of gas release rate can imply a cracking fuel, irradiation sintering of porosity, chemical reactions, grain growth, breakaway swelling, or surface changes. (12 references) (auth)

50247 LATCHES FOR SERIALLY INTERLOCKING NUCLEAR FUEL BUNDLES. Lambert, James Euan (to Atomic Energy of Canada Ltd.). British Patent 1,205,681. 16 Sep 1970. Priority date 11 Oct 1967, Canada.

50248 LIQUID-SAFETY ROD SYSTEM FOR A NUCLEAR REACTOR. Agazzi, Alberto; Broggi, Armando; De Paratesi, Sergio Galli; Ghiurghi, Luciano (to EURATOM). British Patent 1,205,849. 16 Sep 1970. Priority date 26 Oct 1967, Belgium.

REACTOR CONTROL SYSTEMS—design of hydropneumatic shutdown system for liquid poison injection (H.D.R.)

50249 NUCLEAR REACTOR FUEL ELEMENT. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,205,350. 16 Sep 1970. Priority date 23 Dec 1968, Germany.

REACTOR FUEL ELEMENTS—fission gas plenum design for prevention of pressure buildup in (H.D.R.)

50250 VENTED NUCLEAR FUEL ELEMENT. Gauthron, Maurice (to Commissariat a l'Energie Atomique). British Patent 1,205,283. 16 Sep 1970. Priority date 13 Jul 1967, France.

REACTOR FUEL ELEMENTS—design of liquid metal cooled, with porous plugs for fission gas venting

REACTORS, LIQUID METAL COOLED—fuel elements for, design of vented (H.D.R.)

50251 IMPROVEMENTS IN AND RELATING TO CONTROL RODS FOR NUCLEAR REACTORS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,204,938. 9 Sep 1970. Priority date 11 Oct 1967, Germany.

REACTOR CONTROL ELEMENTS—design of hollow rod for insertion into bed of spherical fuel elements

REACTORS, PEBBLE BED—control elements for, design of hollow (H.D.R.)

50252 SPACER GRID FOR NUCLEAR REACTOR FUEL ELEMENT ASSEMBLY. Delafosse, Jacques; Viaud, Jean-Luc (to Commissariat a l'Energie Atomique). British Patent 1,204,657. 9 Sep 1970. Priority date 2 Jul 1968, France.

50253 NUCLEAR REACTOR INSTRUMENTATION (IN-CORE). AN AEC MONOGRAPH. Boland, James F. Monograph Series on Nuclear Science and Technology. New York; Gordon and Breach, Science Publishers, Inc. (1970). 240p. $12.00. (TID-25525).

The basic equations, design descriptions, and operating principles of instruments for making measurements in or near the

core of a nuclear reactor are presented. Radiation effects on instrument and circuit performance are reviewed. Instruments for measuring pressure, displacement, liquid level, flow, temperature, and neutron and gamma flux are described. Special instrument requirements and methods for transient tests and void and boiling measurements are discussed. (H.D.R.)

50254 QUALITY CONTROL OF NUCLEAR REACTOR COMPONENTS. Fuerste, W. (Fried-Krupp, Essen). Tech. Mitt. Krupp, Werksber.; 28: 49-53(Jul 1970). (In German).

Securing the quality of nuclear reactor components is a major requirement to be met by manufacturers. Quality planning, quality control, quality records and the organization of testing and inspection procedures are the four governing factors in any approach to a cost-oriented quality control scheme. The records that must be kept for tests and inspections are quite extensive. In order to save personnel and to assign them only to the actual tests and inspections, it is necessary to organize quality control planning in such a way that in future in-process control will be carried out through a data processing center. A proposal is outlined for a quality control scheme that ensures the reliability of nuclear reactor components and proper scheduling of orders. (auth)

50255 MEASUREMENT OF THE NEUTRONIC INTERACTION BETWEEN TWO CYLINDRICAL MODERATORS. Grosshoeg, G. (Chalmers Univ. of Tech., Goteborg). Nucl. Sci. Eng.; 42: 16-22(Oct 1970).

The stationary interaction parameter between the plane surfaces of two identical, cylindrical, polyethylene disks has been measured with the pulsed neutron method. It was shown that it is possible to overcome the delay effect caused by the flight of the neutrons in the gap between the moderators through the insertion of absorbers. In the measurements the ratio of separation distance to diameter was varied between 0.06 and 0.77; the resulting values of the interaction parameter varied from 0.93 to 0.24. Two different thicknesses of the disks were employed; one assembly gave decay constants from 10,000 to 17,000 sec^{-1} and the other assembly yielded values in the range 17,000 to 40,000 sec^{-1}. Although full equilibrium of the neutron distribution was not reached in all cases for the last series, the two series show a general agreement. A calculation based on a zero'th-order Bessel function as radial distribution and $(\cos\theta)/\pi$ as angular distribution of the neutrons leaving the interacting surfaces gives a too-large interaction parameter for all separation distances. However, the overestimate is small when the surfaces are close together. (auth)

50256 NUCLEAR REACTOR FUEL ASSEMBLY. (to Westinghouse Electric Corp.). British Patent 1,206,579. 23 Sep 1970. Priority date 12 Sep 1968, United States.

REACTOR FUEL ELEMENTS— spacers for hexagonal arranged rod type, description of torsion bar and spring finger (D.C.C.)

50257 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Mills, Colin Patrick (to Atomic Power Constructions Ltd.). British Patent 1,206,640. 23 Sep 1970. Filed 30 Nov 1967.

Reference is made to reactors of the type in which the core with its side shield is housed within a metal pressure bell inside the main pressure vessel, and the side shield comprises an annular assembly of columns of a neutron absorbing material such as $Ca(OH)_2$, extending over the height of the core and disposed so that there is no straight free path for radiation. It is found that difficulties arise in construction of the side shield because of the length of the columns and the limited space inside the pressure bell. In the system described the side shield is erected by passing through an access hole in the domed roof of the pressure bell, tubes of moderator material whose length and cross section permit them to be maneuvered through the access hole and into operative positions inside the pressure bell. The access hole is positioned in a part of the pressure bell roof where the curvature in the vertical plane is greatest. The tubes may be of steel construction, and circular, rectangular, triangular or hexagonal in shape. They may be arranged in a series of concentric circles round the core, each circle comprising columns of several layers of superimposed tubes. Joints may be staggered to eliminate any possibility of a straight-through path for radiation, or alternatively the abutting ends of the tubes may be levelled or otherwise appropriately shaped for the same reason. Spacers may be fitted to some of the tubes of the innermost row to space such tubes from the reactor restraint cylinder, and other adjacent rows may also be spaced to permit coolant circulation. The lower ends of tubes in the lowermost layers may have locating means to ensure correct positioning. (UK)

GENERAL

50258 (ACRH-1000-220) CYTOGENETIC STUDIES IN MALIGNANT LYMPHOMAS AND RELATED DISORDERS. Erkman-Balis, Bayzar; Rappaport, Henry (Argonne Cancer Research Hospital, Chicago, Ill.). [1969]. 15p. (CONF-700507-3). Dep. CFSTI.
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50259 (ANL-7707) MVT ACCOUNTING ROUTINE FOR RELEASE 17 OF OS/360. Snider, David R. (Argonne National Lab., Ill.). Jul 1970. Contract W-31-109-eng-38. 29p. Dep. CFSTI.

50260 (ANU-P-460) CHARGE IDENTIFICATION FOR SPECTRAL LINES IN NITROGEN. Bashkin, S.; Carriveau, G. W.; Hay, H. J. (Australian National Univ., Canberra. Dept. of Nuclear Physics). [1970]. Contracts N00013-67-A-0209-0005; F33615-70-C-1007. 10p. Dep. CFSTI (U. S. Sales Only).

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50266 (CALT-767-P-5-3) MUTATIONAL ANALYSIS OF DEVELOPMENT IN DROSOPHILA MELANOGASTER. Lewis, Edward B. (California Inst. of Tech., Pasadena. Div. of Biology). 28 Aug 1970. Contract AT(04-3)-767. 8p. Dep. CFSTI.

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Thesis.

50279 (IS-T-404) A SPECTROPHOTOMETRIC STUDY OF THE EQUILIBRIUM FORMATION OF THE GASEOUS SPECIES BISMUTH (I) TETRACHLOROALUMINATE AND TELLURIUM (II) CHLORIDE. Lynde, Richard Arthur (Ames Lab., Iowa). Sep 1970. Contract W-7405-eng-82. 79p. Dep. CFSTI.
Thesis.

50280 (KAPL-3859) DETERMINATION OF TRANSIENT CHARACTERISTICS OF AN X-RAY VOID MEASUREMENT SYSTEM FOR USE IN STUDIES OF TWO-PHASE FLOW. Jones, O. C. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb 1970. Contract W-31-109-eng-52. 11p. Dep. CFSTI.
A steady-state x-ray system in existence at KAPL was modified for use in determining transient variations in void fraction in two-phase, gas-liquid flow. The capabilities of this system are reviewed and discussed from both a void level and fluctuation frequency standpoint. (auth)

50281 (NVO-416-2) TEST EVALUATION OF EXPLOSIVELY BONDED CASING-LIFTING RING ASSEMBLIES. (Tyco, Louisville, Colo. Explosive Fabricators Div.). Apr 1970. Contract AT(26-1)-416. 52p. Dep. CFSTI.

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Thesis.

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50292 (RLO-2226-T-1-4) STUDIES OF GENETIC ALTERATIONS IN HUMAN CELLS AND MOLECULES AND THE FACTORS INFLUENCING THEM. Progress Report, August 1, 1969-July 31, 1970. (Oregon Univ., Portland, Div. of Medical Genetics). Contract AT(45-1)-2226. 93p. Dep. CFSTI.

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